Materials & Methods

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EAST ENGINEERING

How to Evaluate High Temperature Properties of Materials

Heavy Rhodium Electroplates Now Possible

New Wood Flour Moldings

Salt Bath Case Hardening with Molybdenum and Tungsten

Seven Kinds of Plastics Pipe

Planning for Consistent High Quality Spot Welds

Prepainted Steel Strip for Production Forming

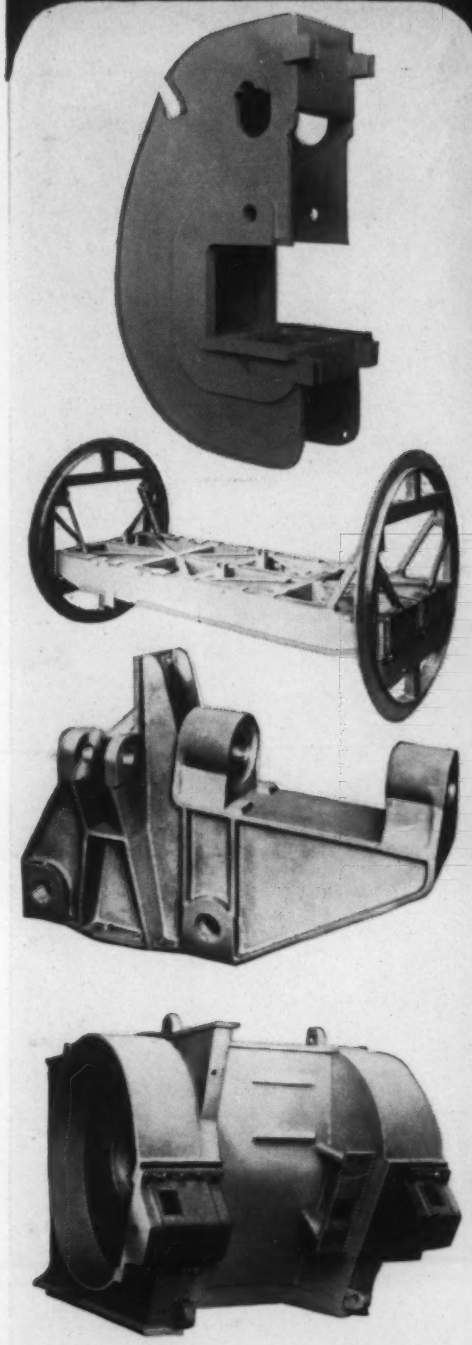
Properties of Tin and Tin Alloys

MALLEABLE IRON CASTINGS
—Materials & Methods Manual No. 92

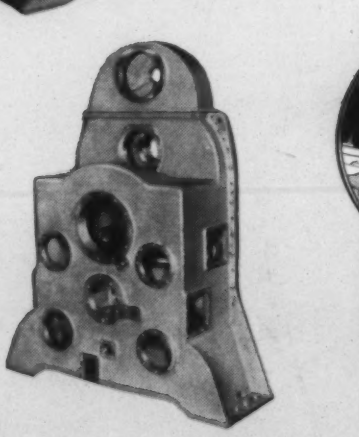
MARCH
1953

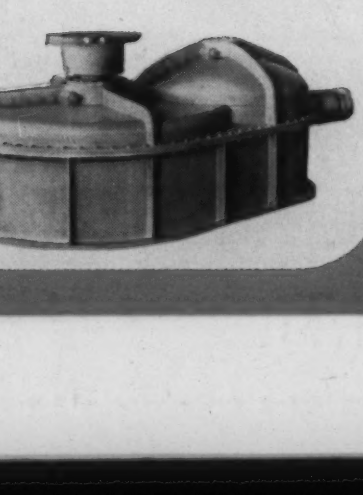
THE MAGAZINE OF
MATERIALS ENGINEERING
DEVOTED TO THE MATERIALS PROBLEMS OF PRODUCT DESIGN AND MANUFACTURE

Steel-Weld FABRICATION



Use WELDED STEEL for Greater Strength with Less Weight!





In the illustration above you see a portion of the Mahon machine shop where welded steel parts and assemblies of various sizes and weights are machined to specification for many industries throughout the country. Facilities are available right in the Mahon plant to do the complete job from the drawing board to finished machining ready for assembly. If you have parts or assemblies that can be redesigned and produced to better advantage through Steel-Weld Fabrication, or, if you are faced with a production problem involving large heavy pieces in which pattern costs are a consideration, you can turn to Mahon with complete confidence. You will find in the Mahon organization a unique source with complete, modern fabricating, machining and handling equipment to cope with any type of work regardless of size or weight ... a source where skillful designing and advanced fabricating technique are supplemented by craftsmanship which assures you a smoother, finer appearing job embodying every advantage of Steel-Weld Fabrication. See Mahon's Insert in Sweet's Product Design File, or write for further information.

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MAHON

Materials & Methods®

THE MAGAZINE OF MATERIALS ENGINEERING • VOL. 37, NO. 3 • MARCH, 1953

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Reentered as second class matter July 19, 1951, at the Post Office at New York, N. Y., under the Act of March 3, 1879. Established in 1929 as Metals and Alloys.

Another new development using

B. F. Goodrich Chemical *raw materials*

B. F. Goodrich Chemical Co. does not make this plastic pipe. We supply the Geon resin only.

THIS rigid polyvinyl plastic pipe is doing a beautiful job of carrying highly corrosive, acidified dilute brine, where other types of hose or pipe caused difficult problems.

For example, when rubber hose was used, it plugged up because the rubber particles carried in the brine tended to stick to the side of the hose. This meant dismantling and unplugging the hose about every three months.

With metal pipe, the rubber particles would stick to the welding. And another type of corrosion-resistant pipe was hard to install and broke easily.

This rigid plastic pipe, made with Geon polyvinyl chloride resin, takes care of all those problems and more! Pipe like this can be made rigid *or* flexible, useful for underground or overhead piping to carry liquids or gases.

It resists soil acids or alkalies and electrolysis. No protective coating or wrapping is needed. It can be made light enough for a small boy to lift easily. Polyvinyl plastic pipe is four to six times lighter than steel pipe of equal length, diameter and wall thickness.

To the economies in use and maintenance, add the savings in racking, stringing, handling, freight and shipping costs with plastic pipe like this!

It's another example of how Geon materials help improve or develop products, and lower costs. Perhaps they can help you. For technical information, write Dept. GN-2, B. F. Goodrich Chemical Company, Rose Building, Cleveland 15, Ohio. Cable address: Goodchemco. In Canada: Kitchener, Ontario.

GEON RESINS • GOOD-RITE PLASTICIZERS . . . the ideal team to make products easier, better and more saleable.

GEON polyvinyl materials • HYCAR American rubber • GOOD-RITE chemicals and plasticizers • HARMON organic colors

The Materials Outlook

Manufacturers of civilian-type products will receive during the next quarter allotments of steel higher than any yet granted under the Controlled Materials Plan . . . But steel plate, heavy structural shapes, tubular products and certain other items are expected to remain scarce for some time yet.

Although copper supply appears to be on the mend, it is low in terms of the government's stockpiling objectives. As a result, second-quarter allotments will show only slight increases. The projected return to a free market later this year may bring about higher domestic production. Meanwhile, government economists seem to be pinning hopes for near-future improvement on the possibility of lower ammunition requirements in Korea and progress in substituting steel for copper in shell cases.

Producers' stocks of refined copper totalled only 24,000 tons at year's end. This was the smallest amount on hand at the end of any year since 1906, according to the Bureau of Mines. The figure represents a 30% decline during the past year. The decline is attributed to higher copper consumption, coupled with lower mine output in this country. Market men see the increased use of copper, and particularly the estimated 25% jump in high-priced copper imports last year, as a sign of continued high-level demand for the critical material.

Outlook for aluminum is for increasingly available supplies for nonmilitary uses in the months ahead. Taking the long range view: aluminum capacity now is still only 68% of the goal set for the end of 1954, but the expansion programs necessary to meet this goal are already underway. Some market men predict a surplus of aluminum about 1956, but they think demand will catch up again by 1960.

The National Production Authority is currently considering a plan which would bring about an orderly redistribution of idle and excess aluminum in the hands of military contractors and others. Recommendations for such action were made recently by a task group of the Aluminum and Magnesium Warehouse Industry Advisory Committee. The task group reported that large quantities of idle and excess aluminum are being and will be generated this year by changes in specifications for military items.

The eleven "most critical" materials remaining on the DPA list, among which are titanium, nickel, cobalt and molybdenum, do not share in the generally favorable picture for the major metals. In most cases, supplies

(Continued on page 4)

The Materials Outlook *(continued)*

of these materials are increasing, but they are being largely channeled into the defense program.

Standards for polyethylene film are now under consideration by the industry. The study is being coordinated by the Society of the Plastics Industry and has the cooperation of the National Flexible Packaging Assn. Meanwhile, a recommended standard on general purpose vinyl film is already being circulated to the industry and the public for acceptance.

Large plastics molding machines are standing idle in many plants. In some quarters this is seen as ample evidence that the future lies in moldings limited to 60 oz. Expansion is foreseen in the direction of composite construction, utilizing vacuum-formed sheet and injection-molded small parts joined by adhesives.

However, complete refrigerator box molded entirely of plastics is a definite future possibility, according to another plastics specialist. New styrene copolymer moldings, comparable with steel in strength, offer two important advantages: they cannot rust, and, since color is molded in, they need no paint. Current large volume production of styrene monomer is bringing down costs of plastics based on it. As a result, styrene copolymers are already being used for large-size parts in automobiles and home appliances.

Largest producer of sponge titanium is expanding its facilities to keep pace with nation's enlarged titanium-rolling capacity and increasing jet plane requirements . . . . One of the newest titanium rollers is planning a significant increase in production facilities within the next few months.

Current research and development work with organic plastic and glass bonded mica points the way to new solutions to the problems of selecting materials and designing insulation for high temperature-high frequency applications. Synthetic mica-filled tetrafluoroethylene and trifluorochloroethylene are two of the materials under consideration. Object is a material that will overcome high temperature weakness of plastics and provide good electrical properties.

Of more immediate interest in the high temperature-high frequency electrical field are new silicone compounds, reported by two laboratories, which maintain good dielectric properties at temperatures up to 400 F. They can be used for coating glass cloth, impregnating class H equipment and bonding glass laminates.

Hardness increases of over 100 VHN can be obtained in certain binary titanium alloys by low temperature aging. Battelle metallurgists have produced such increases by aging at temperatures as low as 212 F alloys containing about 5 to 8% chromium or manganese after air cooling or quenching in liquid nitrogen.

INCOLOY INCOLOY INCOLOY INCOLOY INCOLOY INCOLOY INCOLOY INCOLOY INCOLOY

Latest facts about INCOLOY

Newest member of the Inco family

Incoloy® was developed as a companion to Inconel®, long considered one of industry's most durable high temperature metals.

The latest test results now definitely establish the importance of Incoloy as a new high temperature material. (See tables.) In fact, its most useful mechanical properties are comparable to those of Inconel at temperatures up to 1800°F.

Both metals offer good resistance to oxidation. But Incoloy, having a lower nickel content, is likely to provide greater resistance to sulfur attack.

In structure, Incoloy is stably austenitic, and shows no tendency to become embrittled by precipitation of sigma or carbidic phases after prolonged exposure to intermediate temperatures.

Note also, in the tables, the important preliminary creep and rupture data which have been developed on Incoloy.

Like Inconel, the new alloy is readily workable, both hot and cold. Its rate of work hardening is practically the same as that of Inconel. And Incoloy can be welded by commonly-used methods.

All of the usual mill forms are produced — billets, rounds, flats, hexagons, sheet and strip, rods, tubing and wire. Consult your distributor of Inco Nickel Alloys for the latest information on availability from warehouse and mill. And remember — it usually helps to anticipate your requirements well in advance.

Remember, too, that you can always call on Inco's High Temperature Engineering Service for assistance in selecting the *right* metal for any high temperature application. All you need do is write and ask for a copy of the "High Temperature Worksheet." This is a simplified form especially designed to help you highlight the essential facts of your particular problem. The International Nickel Company, Inc., 67 Wall Street, New York 5, N. Y.

Incoloy

Preliminary Creep and Rupture Data
Condition: Course Grained-Annealed*

Creep

Stress, psi, to Produce a Minimum Creep Rate of:		
Temp. °F	.01% 1000 hrs.	.10% 1000 hrs.
1400	4400	5500
1600	2000	2900
1800	250	500
2000	....	200**

Rupture

Stress, psi, to Produce Rupture in:			
Temp. °F	1000 hrs.	10,000 hrs.	100,000 hrs.
1400	8700	6000	(4200)
1600	3800	2200	(1300)
1800	1700	1100	(670)
2000	850	(540)	....

*2 hrs. 2050°F AC
**.07% 1000 hrs. (4000 hrs.)

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Incoloy... *for Heat-Resisting Applications*

Steel Capacity: Index of Strength in War and Peace

Maximum Production of Critical Forms Has Been Determined. The Big Question: Is It Enough in Case of Total War?

The steel industry, with a current ingot capacity of 117 million tons, is expected to have a potential of 124 million tons when expansion programs now planned are completed. Such capacity will represent an increase of 25% since the beginning of 1950 and a level 38% above the highest reached during World War II.

Whether the new capacity will be sufficient for the country's needs, particularly in the event of war, is problematical. The fact remains that the steel industry has already achieved about 96% of the goal set for it.

Some critics of the steel industry have suggested that too great a portion of this government-subsidized expansion has been devoted to developing capacity for producing the lighter steel products more suitable for civilian consumption than for wartime production needs.

According to an interim report released a few weeks ago by the Defense Production Administration, however, the largest portion of the certificates of necessity granted to iron and steel companies by the Government have been for expansion of basic steelmaking facilities and raw materials. Only about 25% has been funneled into finishing capacity.

The DPA report, moreover, makes it clear that as yet no valid basis exists for comparison of steel output potential with military and other requirements during a full mobilization period. Such a comparison must await the results of a study now getting under way which will attempt to ascertain these military requirements.

The first step in such a comparison —determining the output potential— has been taken. The DPA report lists eight steel products which it considers "critical" in a full mobilization period, and the maximum annual production of these forms at the conclusion of the present expansion program has been determined. Figures are presented in the accompanying table.

Eight Critical Steel Products

Form	1950 Shipments* (Tons)	Max. Annual Production at Conclusion of Expansion Program (Tons)**
Standard Rails, Heavy	1,729,000	2,649,000
Hot Rolled Bars, incl. Tube Rounds, 1½-9½ in.	5,845,000	21,538,000
Tube Rounds Produced on Mills Capable of Producing Tube Rounds Only (incl. above)	—	(4,072,000)
Cold Finished Bars 1 7/16 in. and over	552,000	2,307,000
Heavy Structural Shapes and Piling	4,591,000	9,560,000
Wide Flange Beams and Bearing Piles (incl. above)	(2,000,000)	(2,645,000)
Plates—Strip Mill	733,000	6,260,000
Plates—Sheared	4,875,000	8,676,000
Plates—Universal	964,000	4,460,000
Seamless Pipe and Tubing	3,310,000	4,939,000

** Figures exclude shipments to members of industry for conversion into further finished products or resale.*
*** These figures are not addative, inasmuch as flexibility of equipment makes it possible to expand production of a particular form at the expense of another.*

The figures given for output potential reflect the extreme flexibility of the steel industry's rolling and finishing mill capacity. Any one type of finishing mill may produce several different steel products, and finishing mill capacity has always exceeded raw steel capacity. Additional flexibility can be obtained by changes and rearrangements, as in World War II when the continuous strip mills were converted to the production of steel plates.

Powerful Plastics Press

A plastics press about 3½ times more powerful than the heaviest commercial presses is now being used by Argonne National Laboratory.

The pneumatic injection press can develop pressures up to 70,000 psi. Such high pressures are needed to make plastic parts in new radiation instruments.

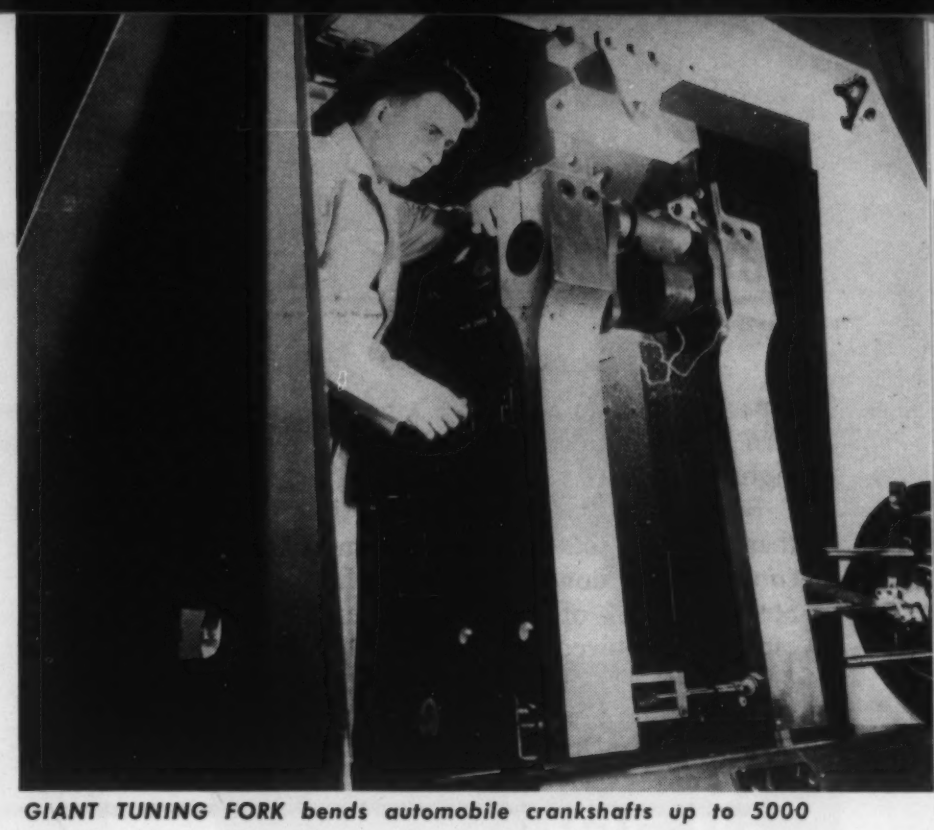
Copper Alloy Shipments Down

Brass and bronze ingot shipments were 16.5% lower in 1952 than in 1951.

Shipments of 277,736 tons, compared to 332,378 in 1951, were reported by the Defense Council of the ingot brass and bronze industry. The 1952 output represents about 60% of the industry's capacity.

Highest output was approximately 500,000 tons in 1944. Lowest output in the last 100 years occurred in 1949, with only 175,000 tons produced.

SPECTROHELIOMETER designed by General Motors measures distribution and daily and seasonal variation of the sun's radiation, and the variation in various parts of the spectrum. This information is correlated with weathering of exposed paint and finish samples.



GIANT TUNING FORK bends automobile crankshafts up to 5000 times a minute. Punishment suffered in years of driving is compressed into a few hours by this machine used by Chrysler Corp. engineers for fatigue tests.

Superior Synthetic Rubber Seen in New Polyester

An entirely new type of synthetic rubber, with greatly increased toughness and abrasion resistance, is on the way. Laboratory tests on the polyester rubber indicate that tires made from it could easily outwear the automobile itself. Basic patents on the material were announced recently by The Goodyear Tire & Rubber Co.

High Wear Resistance

Dr. Dinsmore, Goodyear vice president in charge of research and development, reports that tire treads of the new rubber achieve two to five times greater wear resistance than treads of the best "cold" rubber produced. The polyester is claimed to be equivalent to butyl rubber in air diffusion resistance and equivalent to Neoprene in oil resistance. Its resistance to oxidation, according to Dr. Dinsmore, is far superior to natural or to any other man-made rubber. Tensile strength is described as 50 to 100% better than any other types of rubber-like material.

Important problems have yet to be solved before the new material finds wide use. Resilience and adhesion of the rubber must be improved, processing methods must be further developed, and more economic production of the raw material will be necessary to bring down the cost to a competitive level.

(Continued on page 178)

Eight Leaders Have 77% of Nation's Steel Capacity

With Three-Fourths of the Open-Hearth and Bessemer Capacity, However, They Have Only 30% of the Nation's Electric Steel Potential.

A breakdown of the nation's total steel capacity of over 117 million tons as reported earlier this year by the American Iron & Steel Institute shows that the eight largest companies, of a total of 34, control 77% of the total capacity.

Rank of the leading companies is shown in the accompanying table. Percentage-wise, U. S. Steel has 31, Bethlehem 15, Republic 8.8, Jones & Laughlin 5.5, National 4.8, Youngstown 4.2, Armco 4.0 and Inland 3.8%.

Open-hearth capacity, which accounts for 87.5% of the total steel

(Continued on page 8)

Steel Capacity as of Jan. 1, 1953*

Company	Open-Hearth	Bessemer	Crucible and Electric	Total
U. S. Steel	33,636,000	2,394,000	369,000	36,399,000
Bethlehem Steel	16,704,000	336,000	560,000	17,600,000
Republic Steel	8,222,000	665,000	1,375,000	10,262,000
Jones & Laughlin Steel	5,823,000	582,000	1,500	6,406,500
National Steel	5,650,000	0	0	5,650,000
Youngstown Sheet & Tube	4,707,500	240,000	0	4,947,500
Armco Steel	4,022,000	0	696,000	4,718,000
Inland Steel	4,500,000	0	0	4,500,000
Others	19,413,480	420,000	7,205,990	27,064,470
TOTAL	102,677,980	4,637,000	10,207,490	117,547,470

* *Measured in tons of ingots and steel for casting.*

Adapted from a report by American Iron & Steel Institute

News Digest

capacity, follows about the same pattern as total capacity among the top eight companies.

Bessemer capacity, which is less than 4% of total capacity, is more concentrated, however. Here, U. S. Steel has 52% of the total Bessemer capacity, followed by Republic with 14%, and Jones & Laughlin with 12.5%. Ranking fourth with 9% (420,000 tons) is Wheeling Steel Corp. Bethlehem has 7% and Youngstown 5%.

By way of contrast, the bulk of electric and crucible steel capacity which accounts for about 8.7% of total capacity is much more widely distributed. The eight leading companies have only 30% of the electric and crucible capacity. Although Republic leads with 13.4%, Northwestern Steel & Wire Co. is next in line with 8% (825,000 tons). Armco is third with 7%. Other leading companies in this field rank as follows: Timken Roller Bearing (625,000 tons), Allegheny Ludlum (624,000 tons) and Copperweld (618,000 tons), all about 6%; and McLouth (580,000 tons) and Bethlehem, each about 5.5%. The total electric and crucible capacity of all these companies represents only 57% of the national total.

New Materials in Limelight at Annual SAE Meeting

Titanium's Limitations Get an Airing. Aircraft Industry Needs Better Transparent Plastics.

Titanium—the "wonder metal"—has had some of its gloss removed recently as designers and production men buckle down to the job of trying to overcome its limitations.

It is still the hottest subject in the metals field, however, and it claimed a major share of attention from the engineers and designers who gathered in Detroit earlier this year for the annual meeting of the Society of Automotive Engineers.

With many potential civilian applications of titanium hanging on the price-availability question, much interest naturally centered on a progress report by one of the leading producers in the field. According to Rem-Cru Titanium's C. I. Bradford, Director of Operations, "tonnage titanium production has arrived."

As proof, he cited the following facts:

(1) Up to 5 tons per day of metal are being produced. Facilities for 20 tons per day are under construction.

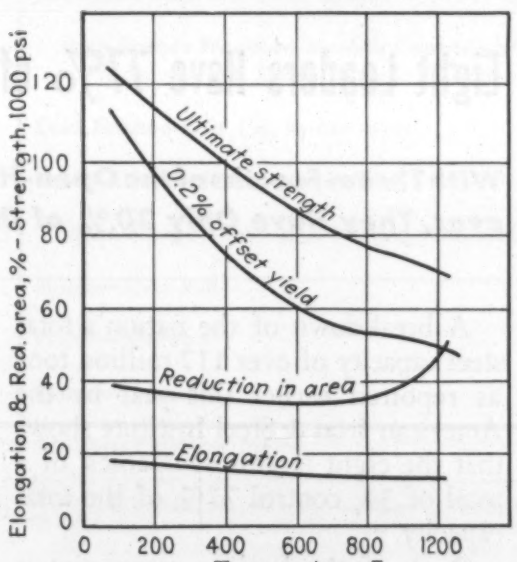
(2) Two-ton ingots are being made.

(3) Continuous wide strip processing is a reality.

(4) Reliable alloys are available in virtually all the standard forms in which stainless steel is produced.

(5) Quality is under control.

(6) Production applications are now established in both airframes and jet engines.



Typical properties of "alpha" type titanium.

He pointed out that all this had been achieved at a price level for wrought forms of from $10 to $20 per lb.

Alpha Type on the Way

For those aircraft engineers who would be willing to forego some of titanium's present workability in return for better hot strength, Mr. Bradford had good news: the imminent production of an alloy of the "alpha" type. The alpha phase structure offers, in addition to good hot strength, improved corrosion resistance and weldability. Commercial alloys now available are of the alpha-beta type, with good bendability but rather low hot strength.

Typical properties of the forthcoming alpha-beta alloy are shown in the accompanying graph.

Mr. Bradford sees a bright future for titanium, once its price is reduced enough to make it competitive with other structural materials. He marked particularly the trend in the transportation field toward higher speed, lighter weight, higher strength and more severe corrosion resistance. This trend has widened the gap between

(Continued on page 164)

Briefs

NEW POWDER METALLURGY GROUP—The growing interest in powder metallurgy has resulted in the emergence of a new technical group whose aim is the advancement of this field. Called the Powder Metallurgy Committee, it is a sub-division of the Institute of Metals Div. of the American Institute of Mining & Metallurgical Engineers.

Membership is open to nonmembers of AIME as well as members. Information can be obtained from AIME headquarters, 29 West 39th St., New York 18.

●

RADIOISOTOPE SYMPOSIUM—A two-day symposium on "Management Problems in Industrial Application of Radioisotopes" is scheduled for Apr. 30 and May 1 by the Oak Ridge Institute of Nuclear Studies in Oak Ridge, Tenn.

The meeting is open to management personnel of companies interested in incorporating radioisotopes

(Continued on page 11)

News Digest

continued from page 8

or other atomic energy products into their research or production activities.

The symposium coincides with the end of a course on "Advanced Radioisotope Techniques in Industry" for research personnel, which will start on Apr. 20.

Application blanks and additional information on the course and symposium can be obtained from the Special Training Div., Oak Ridge Institute of Nuclear Studies, P. O. Box 117, Oak Ridge, Tenn.

●

PAINT COURSE OFFERED—A three-day course in the fundamentals of "Paint as an Engineering Material" will be held Mar. 30 to Apr. 1 at Case Institute of Technology, Cleveland.

Sponsored by the Dept. of Chemistry and Chemical Engineering, the symposium will review the theory and practice of coatings engineering. Critical problems of specification and application of organic finishes will be considered, with particular reference to recent efforts to evaluate and use the newer types of synthetic resin finishes.

General topics scheduled for the course include: factors which influence the adhesion of organic coatings; causes and remedies of other paint application faults; design and interpretation of experiments for field or service testing; accelerated laboratory tests for prediction of service properties of coatings; and metal protection in severely corrosive environments.

●

AERONAUTIC PRODUCTION FORUM—An open Aeronautic Production Forum will be held by the Society of Automotive Engineers Apr. 20 at the Hotels Governor Clinton and McAlpin in New York City.

The one-day forum will cover 10 major subjects of importance to the aviation industry, the discussion in each session being conducted by a panel of industry experts.

The materials interest will center on sessions in Titanium, Large Forgings and Castings, Jet Engine Buckets and Blades, Precision Forming and Joining, Machining, and Inspection and Quality Control. Other sessions will cover Experimental Manufacturing, Machine Tools and Tooling, Manufacturing Management and Production Procurement.

where HARD RUBBER is right...
use it!
...and it's RIGHT for ELECTRICAL PARTS
high dielectric
arc-resistant
heat-resistant
tough, wear-resistant
It's because hard rubber is far more than "just a good insulator" that it's used in so many electrical parts. The familiar red magneto part above, for instance. It had to be wear-resistant and strong at 300° heat . . . and easily moldable with 17 inserts . . . in addition to high arc resistance (248) and high dielectric strength (600 v/mil). It's Ace Super Magnon hard rubber.
Many Ace compounds . . . some with tensiles as high as 10,000 psi. and moisture absorption as low as 0.04% . . . materials like the low power factor (0.6%), rigid X-2-B sheet for punched parts . . . and other Ace plastics such as high-impact (5.8 Izod) Ace-Hide; Saran, polyethylene, acrylics, etc., are covered in the new Ace Handbook. Keep it under your thumb when designing for today's production and tomorrow's plans.
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TRAD

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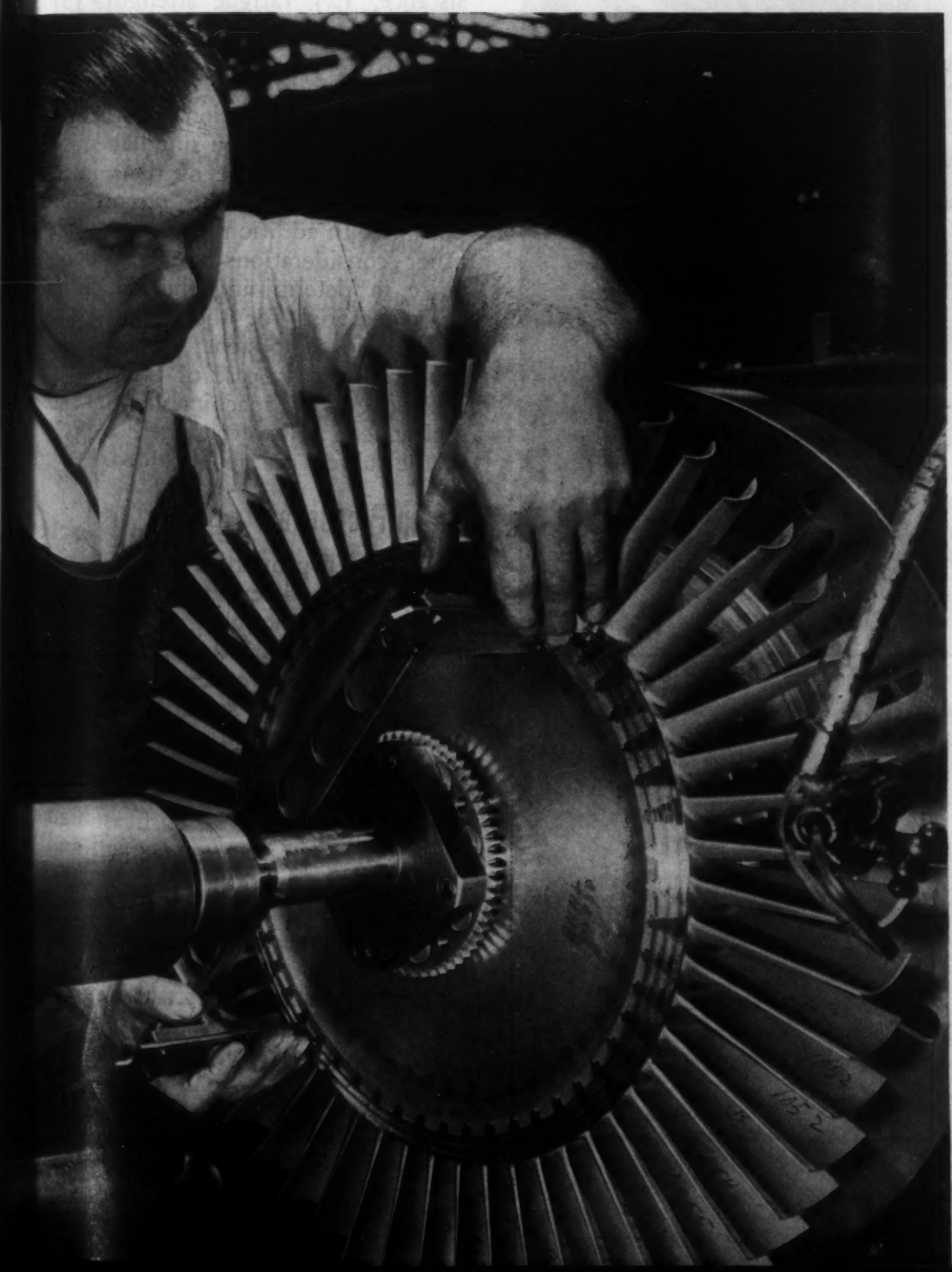
Materials & Methods
March 1953

How to Evaluate High Temperature Performance of Materials

Time is the important controlling factor in elevated temperature applications . . . and creep, fatigue, corrosion resistance and thermal shock are the time-dependent properties to consider in judging materials for such service.

by **L. B. PFEIL**, Manager of Development and Research Dept., Mond Nickel Co., Ltd.



With all blades in place, a final check is made on the diameter of seal grooves before the ring which locks blades in place is installed. (Pratt & Whitney)

● THE DESIGN OF mechanisms or structures for operation at elevated temperatures is more complicated than that of similar devices which operate at normal temperatures, because most of the important properties of the materials of construction are appreciably affected by the time factor. Thus, results of a simple tensile test, which are for practical purposes independent of time at normal temperatures, on which many perfectly satisfactory designs have been based, depend essentially at higher temperatures on the rate of strain. Even the apparent elastic moduli of a material are time-dependent at elevated temperatures, higher values being obtained by dynamic testing methods than by static methods.

Knowledge of the time-dependent properties of materials is essential in

Nimonic 80A blades are fitted into pine-tree shaped slots in a turbine disk with sufficient room to allow for expansion and contraction. (Pratt & Whitney)

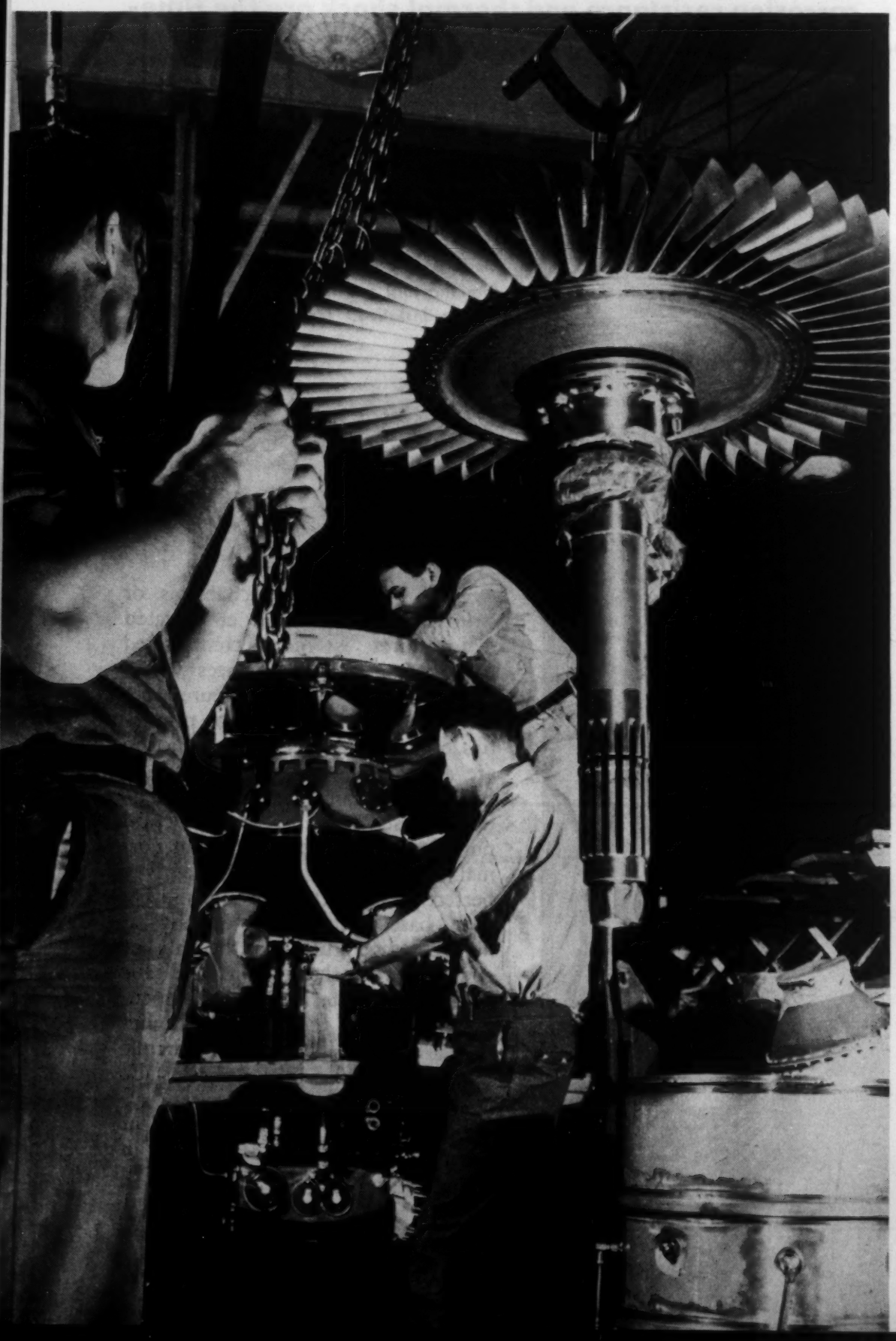
selecting the most suitable material for any given conditions of service, and this article deals with the more important of the relevant properties, with particular reference to materials of construction for gas-turbine engines. The term *elevated temperature,* as applied to materials of construction, implies a temperature at which the material's properties are essentially dependent on the time factor; it is, therefore, a relative term. The remarks, although restricted almost entirely to steels and alloys for high temperature service, would be equally applicable to lead, tin and other low-melting-point materials at normal temperatures.

The properties most important in materials for high temperature service are the following: (1) Creep resistance, (2) fatigue strength, (3) resistance to corrosion, and (4) resistance to thermal shock.

Since conditions conducive to creep, fatigue, corrosion and thermal shock are likely to be simultaneously operative, knowledge of their interrelationship is of the utmost importance. In addition to these factors, other considerations are of importance in determining the suitability of a material for the manufacture of a given component; for example, availability, cost, ease of fabrication, specific gravity, machinability, weldability, etc. However, these aspects of the subject are not included.

Creep Properties

The creep properties of a material are normally determined in tension under a constant load, although for specific purposes other tests of a similar nature have been used. Torsion creep tests are sometimes carried out, either because in a particular application torsional characteristics are important or because the practical advantages of the test, such as high sensitivity of strain measurement and



Completed turbine assembly and shaft are hoisted into position for insertion into a Turbo-Wasp engine. (Pratt & Whitney)

nondependence of the strain measurement on thermal expansion, are beneficial. A cantilever-bending method of creep testing has also been proposed, as offering advantages in simplicity for tests on unmachinable alloys, precision castings, or sintered products, and for testing at temperatures of 2000 F or higher. Stress-relaxation tests, with constant strain, are frequently made, and are of importance in such service applications as high temperature bolts; the results depend, essentially, on the tensile creep properties.

A summary of much of the major work on creep testing has been made by Sully, who also reviews theories which have been advanced to explain the mechanism of creep. It is of interest to note that the British Standards Institution has recently issued schedules covering conditions for creep and stress-rupture testing of high temperature alloys.

From the engineer's or designer's point of view, a number of characteristics of the creep curve are of importance. First, the amount of plastic extension on loading has to be considered, for such initial strain is sometimes as great as that which takes place subsequently by the true time-dependent creep, particularly when the temperature is relatively low and the stress fairly high. The steady rate of creep during the secondary stage of the curve largely controls the serviceable life of a component if the life is determined by a small amount of permissible extension. Finally, the time at which the creep rate begins to accelerate, *i.e.*, what is usually called onset of tertiary creep, is of importance, since once this has set in, the subsequent behaviour of the material is likely to be erratic.

In particular, onset of tertiary creep has been found to affect deleteriously the fatigue life of a material. If it is decided that, from dimensional considerations, and from need to maintain reliability, the permissible extension of a component shall not exceed that at the onset of tertiary creep, it is necessary to study how this extension varies with the conditions of testing, *i.e.*, with the temperature or with the applied stress. In the case of the Nimonic alloys, when strain at the onset of tertiary creep is plotted against time at various temperatures, it is found that as temperature rises and time increases, tertiary creep begins at lower strains. It is not known how far this relationship between strain, time and temperature, or rather stress, strain and temperature, holds, because few data are available for durations of the order of 10,000 to 20,000 hr.

Heat treatment is a further factor exerting considerable influence on the strain at the onset of tertiary creep, and indeed on the whole shape of the creep curve. It is well known that to obtain adequate creep resistance, a material must be precipitation-hardened. That in itself is not, however, sufficient. While the hardness appears to play some part in determining the amount of initial plastic flow on loading and on the subsequent secondary creep rate, there is another factor which apparently controls the stage at which fracture of the test bar occurs. It is suggested that time of fracture is largely determined by some condition of the grain boundaries, since it is well known that in all but very fast creep tests the fracture is intergranular, and that optimum grain-boundary structure is obtained only by a controlled amount of overaging. This condition may be produced either by delayed cooling from the solution temperature or by precipitation at a temperature higher than that which produces the maximum hardness.

A useful review of the variables controlling creep and rupture strength of high temperature alloys was made in a paper by Freeman et al. The authors made a critical review of available information on the influence of composition, processing conditions and final treatment, emphasizing the need for close control of these factors in order to limit the "scatter" of creep properties in commercially produced alloys.

The tensile-creep curves of a given material, after heat treatment by a suitable method, are usually determined over a range of stresses and temperatures, and several different ways have been preposed for plotting the results. Perhaps the commonest is the plotting, for a fixed temperature, of the stress to produce a given extension against the logarithm of the time. This gives, in general, something approximating very closely to a straight line, over a fairly wide range. A family of such curves is shown in an accompanying figure. It is clear, of course, that such a method of plotting cannot extend indefinitely as a straight line, for it would lead to the development of finite strains under zero stress, but it errs on the side of safety, since extrapolation to longer times than are covered by the tests will tend to give stresses lower than those which the material would actually support.

Another method frequently used to express results of tests at a fixed temperature is to plot the logarithm of the stress to produce a given extension against the logarithm of the time.

Because the mathematical basis of creep curves has not yet been established, there is no justification for assuming that any plots of this type should be straight lines. Great caution must, therefore, be exercised when extrapolating such results to longer times. The stress-log. time plot is to be preferred in view of the more conservative indications on such extrapolation. It is noteworthy also that creep curves are particularly difficult to reproduce accurately on repeated tests.

It must not be thought that this difficulty of reproduction means that the materials concerned are abnormally variable in properties, for the time required to reach any given creep strain is very sensitive to the applied stress. Thus, quite a wide scatter along the time axis usually means relatively small scatter along the stress axis, and it is found that, in terms of stress carrying capacity under specified conditions of temperature and permissible strain, the high-temperature materials are quite as consistent in properties as materials normally tested at room temperature.

A paper by Cross and Jackson deals critically with the extent to which the information obtained from tests currently used can safely be employed for design purposes. The review, which is supported by experimental data on typical high temperature alloys, leads to the conclusion that "extrapolations much beyond actual test conditions are not always reliable and, in general, have no firm theoretical basis . . . a great deal more work must be done, both theoretically and experimentally, in order to put design for high temperature on a sound basis." It is believed that these conclusions would be endorsed by all who have experience in the field of high temperature testing.

Creep properties of materials are, of course, critically dependent on temperature, and even in the class of materials with which we are most concerned, *i.e.*, alloys for service at temperatures around 1300 to 1500 F, dependence on temperature varies quite considerably from alloy to alloy. This is frequently illustrated by plotting the stress, given a particular

strain in a given period against the temperature. Such a plot of the results for Nimonic 80 is shown in an accompanying figure.

It is not to be taken from these remarks that a material should not be used for conditions which have not been covered by an exactly corresponding test, for such a restriction would prevent the use of the more recently developed materials for anything but relatively short-term service. If advantage is to be taken of the properties offered by these materials for long-term service, extrapolation on the time scale is prerequisite and, if carried out from reliable stress logtime data, is unlikely to give any but conservative results. On the other hand, no extrapolation of properties plotted against temperature should be attempted, unless it is known that there are no wide variations in solubilities and no phase changes in the significant temperature range.

Fatigue Properties

Since many components in high temperature service are subjected to fluctuating as well as steady stresses, the fatigue properties are also of importance, and it is of interest, so far as is possible, to combine the results of both creep and fatigue tests in a single diagram.

This can be done as in the method of Gerber in which steady stress is plotted along the abscissa and fluctuating stress along the ordinate, while radial lines from the origin represent constant ratios of fluctuating to steady stress. Points representing the stress conditions required to give fracture in a certain time can be joined to give curves approximating to ellipses. The shape of such curves is, of course, dependent on the frequency of the fatigue component of the stress. Such curves are in process of being determined for the Nimonic alloys; results already obtained for Nimonic 80A at 1290 F and 1380 F are shown. These curves are being determined on machines of the Haigh type, in which the fluctuating stress is tensile and compressive, so that it is of the same type as the steady tensile stress applied.

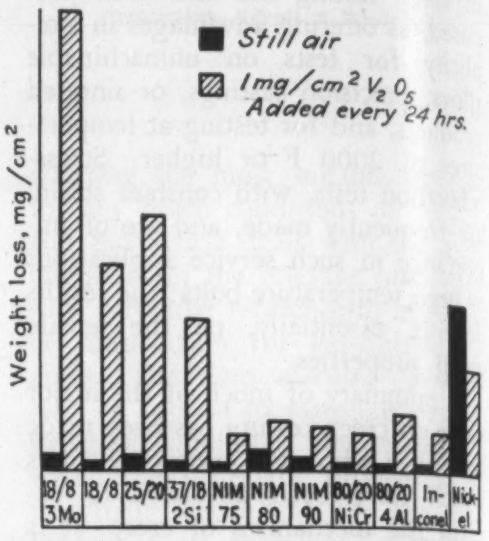
It will be obvious that practical conditions are not always so simple as this. The fluctuating stress can be different in nature from the steady stress, as, for example, in the case of turbine blades, where the centrifugal stress is a steady longitudinal one, while the varying gas bending stress excites vibration of the blades, producing a fluctuating bending stress. Complex stressing of this type is hardly likely to be investigated widely, for the conditions will vary considerably for different applications.

While the steady centrifugal stresses are related to the dimensions of the blade, the specific gravity of the material, and the speed of operation, the fluctuating stresses are caused by blade vibrations, and can be controlled and minimized by suitable design modifications. Vibration in gas turbines has been studied by various investigators, for its effect on the operation of the components, preventive measures, and the technique of testing. Lacing of blades is widely practiced in steam-turbine design, and similar measures, where practicable, in the gas turbine could considerably reduce fatigue stresses. The damping capacity of the blading material may sometimes be of importance in this respect, although with the usual type of mechanical fixing of the blades to the disk, the damping due to the joint is usually far more than that due to the material itself. With blades welded to the disk, however, inherent damping capacity of the material can well have an important influence on the amplitude of the blade vibration.

Service experience in a wide variety of gas turbine engines shows that wrought alloys currently used for moving blades have more than adequate fatigue resistance under the conditions of fluctuating stress caused by the gas flow. The criterion which limits the scope of the design engineer is creep resistance. In these alloys, moreover—at any rate, in those of the Nimonic type—fatigue strength increases with increase in creep strength. On the other hand, there is a distinct possibility that in the future alloys designed for service at still higher temperatures than those required by aircraft turbines of today, maximum creep resistance will not be obtained without some sacrifice of fatigue strength. It will then be necessary to pay close attention to methods of minimizing fatigue stresses, in order to exploit to the full the improved creep properties.

Oxidation and Corrosion Resistance

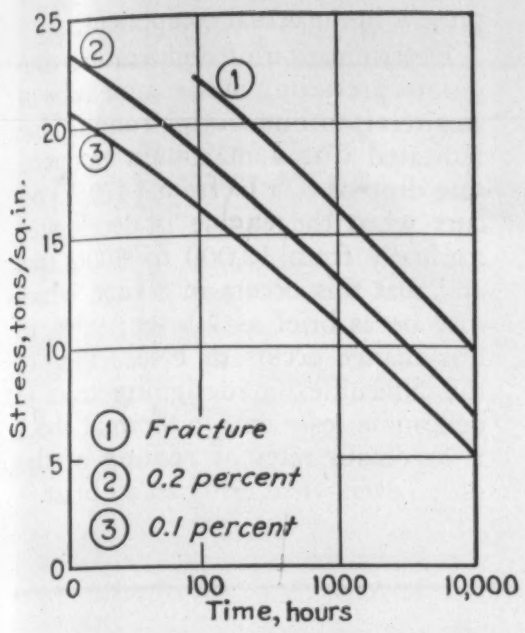
In almost all high temperature materials of importance, resistance to oxidation at elevated temperatures is conferred by the presence of an appreciable percentage of chromium,



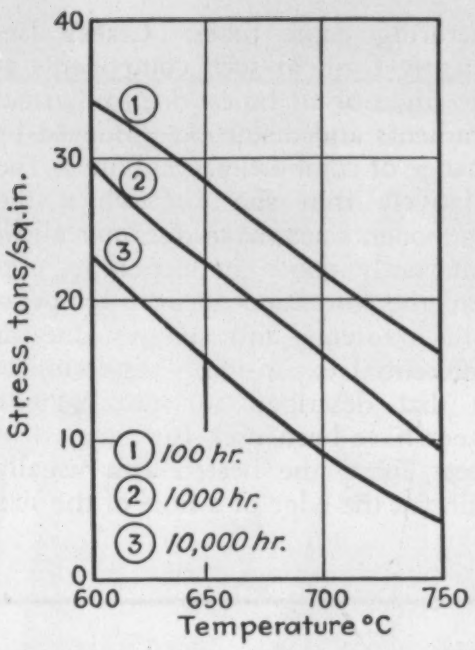
Weight losses of various materials after 284 hr. at 1560 F.

which leads to formation of a protective scale of chromium oxide, Cr_2O_3. Chromium is chosen largely because of its wide range of solubility in the base metals iron, nickel or cobalt, and does not unduly lower the melting point of the alloys. This fortunate coincidence has led to the high temperature materials having adequate scaling resistance in the usual products of combustion at temperatures up to at least 1650 F. Oxidation in service is, therefore, seldom a source of trouble, if the fuel used does not produce combustion products which interfere with the oxide's protective nature. Care must be taken, however, that oxidation occurring during heating for forging, or during heat treatment, does not impair the surface properties of a component. Such oxidation as occurs results in preferential oxidation of the chromium and of other readily oxidized alloying elements, so that the underlying layers of the alloy are impoverished in these elements.

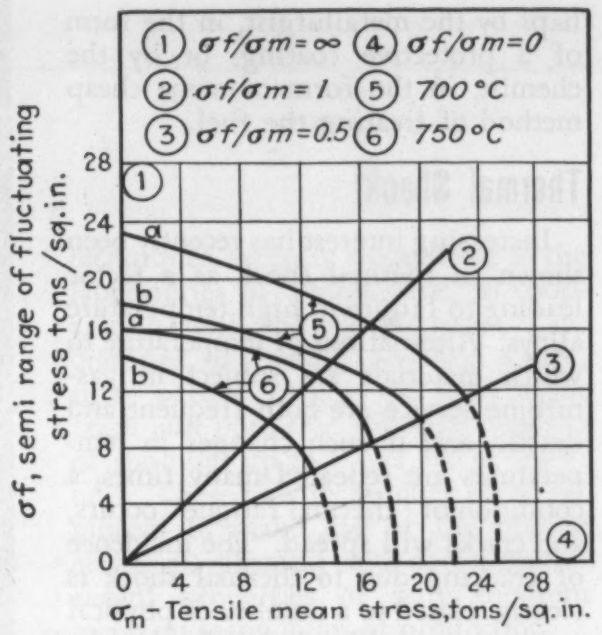
It is well known that some fuels produce combustion products which attack the normally protective oxide films, and thus allow progressive oxidation to proceed rapidly. The most deleterious ingredient found in fuels is vanadium, which, although removed from the distillate fractions



Stress-log. time curves for Nimonic 80 at 1290 F.



Stress-temperature curves for rupture of Nimonic 80 in 100, 1000 and 10,000 hr.



Fatigue properties of Nimonic 80A.

of oils, remains in the residual fractions used as cheaper fuels for marine and stationary turbines.

The method by which ash from vanadium-containing fuels accelerates oxidation of metal components is at present under intensive study by many investigators. It appears that the deterioration produced is predominantly due to action of the vanadium pentoxide, in fluxing the normally protective oxide films. It has also been suggested that V_2O_5 has a catalytic action in promoting oxidation of the metals, but this is thought to be of less importance than the fluxing action. In particular, it is found that only when the melting point of the ash is exceeded is the rate of oxidation considerably accelerated. Pure V_2O_5 melts at about 1240 F, but many ashes occurring in practice contain appreciable percentages of sulfur and alkali metals which can lower the melting point considerably.

Tests made in the laboratory of The Mond Nickel Co. have indicated that the precise nature of test conditions exerts a marked influence on the extent to which vanadium-containing materials affect rates of oxidation. It is difficult to give any fundamental data indicating the magnitude of the effect, but an accompanying figure illustrates the results obtained under one specific set of conditions.

The difference between the nickel-base and the iron-base alloys is probably to be explained in light of the behaviour of pure nickel, on which V_2O_5 caused no increase in oxidation. It is concluded that NiO scale on pure nickel is not fluxed by V_2O_5, and, therefore, remains protective. Although the high resistance of nickel-chromium alloys to oxidation in normal air is due to the presence of appreciable quantities of Cr_2O_3 in their scales, the major proportion of the scale is nevertheless NiO, and it is probably for this reason that they are relatively resistant to the accelerating effect of V_2O_5.

Sulfur is a further constituent of combustion products which is to be considered in the problems of high temperature corrosion. While nickel itself exhibits considerable resistance to V_2O_5, it is very susceptible to attack by sulfur-containing compounds, especially under reducing conditions. Its resistance to sulfur is progressively increased by additions of chromium and iron and, under oxidizing conditions, such alloys as 37 nickel, 18 chromium, 45% iron are highly resistant. In the case of steels, attack by sulfur is substantially prevented by ensuring an adequate proportion of free oxygen in the combustion gases.

It is thus found that while nickel-base alloys give the best resistance to vanadium pentoxide, iron-base alloys are most resistant to sulfur, and, of course, an adequate chromium content is necessary for resistance to oxidation. The effects of different attacking elements are not, however, independent, and it is found that vanadium pentoxide, when in combination with an alkaline sulfate such as sodium sulfate, accelerates scaling by promoting extensive sulfidation of the underlying metal. If the vanadium-sulfate ratio is small, the resulting attack is especially severe on alloys containing more than about 30% nickel, while alloys with inherently good sulfidation resistance are damaged to a much lesser degree. The reverse would be expected if the vanadium-sulfate ratio were high.

When the optimum balance of alloy composition has been found for a given fuel and conditions of combustion it is, nevertheless, not possible today to guarantee complete freedom from vanadium attack without restriction of operating temperatures. A satisfactory solution to the problem remains to be found—per-

haps by the metallurgist, in the form of a protective coating, or by the chemist, in the form of some cheap method of treating the fuel.

Thermal Shock

Increasing interest has recently been shown in thermal shock as a factor leading to failure in high temperature alloys. Alternations of temperature to which materials are subject in gas-turbine service are both frequent and drastic, and if such changes in temperatures are repeated many times, a condition of "thermal fatigue" occurs, and cracks will spread. The incidence of cracking due to thermal shock is clearly related to a number of physical properties, cracking being favored by high values of expansion coefficient, Young's modulus and heat capacity, and minimized by high values of tensile strength and thermal conductivity.

The most useful assessment of materials in this respect has been obtained by various forms of test simulating conditions experienced in service. Thus, one test is related to materials for nozzle-guide vanes, since cracking due to this cause is frequently observed at the trailing edge of such components. This test consists in alternately heating in a blowpipe flame and cooling in a blast of air, using a fixed time cycle and determining the number of cycles before cracks become visible. It is important to note that in such tests it is the conditions of the heating flame and of the time cycle which should be kept constant, not necessarily the maximum temperature reached by the component, since the latter is influenced by specific properties of the material which it is desired to determine. A test of this type was recently described by Gadd.

Tests of this nature have been used to assess the characteristics of ceramics and metal-ceramic mixtures (ceramals), since poor resistance to thermal shock is one of their principal disadvantages. The current stage of development of ceramics, in relation to their use in gas turbines, was the subject of two papers at the recent Iron and Steel Institute Symposium. In both papers the conclusion is reached that ceramics or metal-ceramics must be improved in ductility to make them serviceable under gas-turbine conditions. In the latter type of material it is believed that considerable improvement can be achieved.

Resistance to the effects of rapid changes of temperature is also of importance in materials used for manufacturing flame tubes. Cracks frequently form in such components at the edges of air holes, due to thermal gradients and distortion produced by change of combustion conditions. The relatively thin sheet of which the components are made does not allow sufficiently good conduction to prevent the formation of steep temperature gradients and stresses due to differential expansion. Tests similar to that described for nozzle-guide vanes have been used for material in sheet form, the heated area usually being at the edge of a hole of the size present in the actual component.

Determination of temperature conditions prevailing in the flame tube of an aircraft turbine during running has indicated that a maximum temperature drop of 625 F (from 1470 F) occurs when the engine is decelerated manually from 12,000 to 3000 rpm and that this occurs in a time which may be as brief as 2.5 sec; 90% of this change occurs in 1 sec. One of the difficulties in designing tests to determine resistance to thermal shock is to obtain rates of cooling of this order, even when using an air blast.

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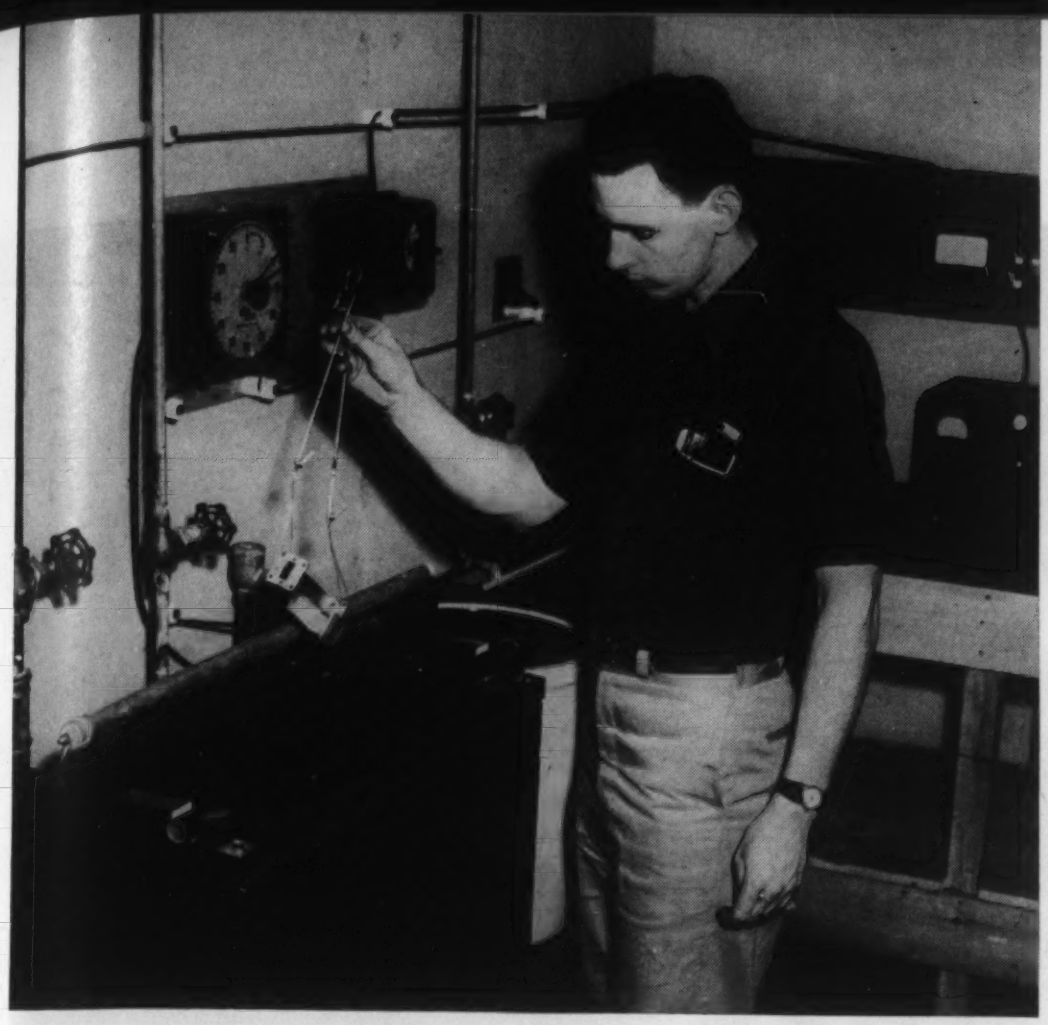


Heavy rhodium plates (up to 0.0005 in.) are applied in regular production runs for the electronics industry. (L. A. Donovan Co.)

Heavy Rhodium Electroplates Now Possible

. . . Can be deposited on most common metals
. . . Provide excellent corrosion and water resistance

by ALFRED M. WEISBERG, Technic, Inc.

● HEAVY ELECTROPLATED RHODIUM is a new and valuable material available to the electrical and mechanical design engineer. Rhodium remains free of tarnish and oxide films and resists chemical corrosion at normal and elevated temperatures. It is one of the hardest electroplated metals and is extremely wear resistant. These physical properties, together with its good electrical properties, have made heavy electroplated rhodium particularly suitable for many applications, such as relay and switch contacts, commutators and sliding contacts, as well as for mechanical and electrical components subjected to extreme wear, highly corrosive atmospheres and high temperatures. The cost may be estimated as approximately $0.18 per 0.000001 in. per sq ft.

Rhodium metal is practically unworkable by normal metal-working techniques. Since 1930 it has been used as a decorative electroplated finish on jewelry and silverware and as a tarnish free reflecting surface on mirrors for searchlights, projectors and other optical instruments. However, electroplated rhodium has usually been limited to deposits of less than 0.00001 in. Some heavier deposits cracked and had dull, rough surfaces and/or poor adherence. New techniques, recently worked out in the laboratories of Technic Inc. in cooperation with the Development Laboratories of Bendix Aviation Corp., now permit bright or semi-bright crack and pore-free adherent deposits of rhodium up to 0.001 in. in thickness. These new techniques allow engineers to make use of the unique electrical, physical and corrosion resistant properties of pure rhodium metal on many items of production.

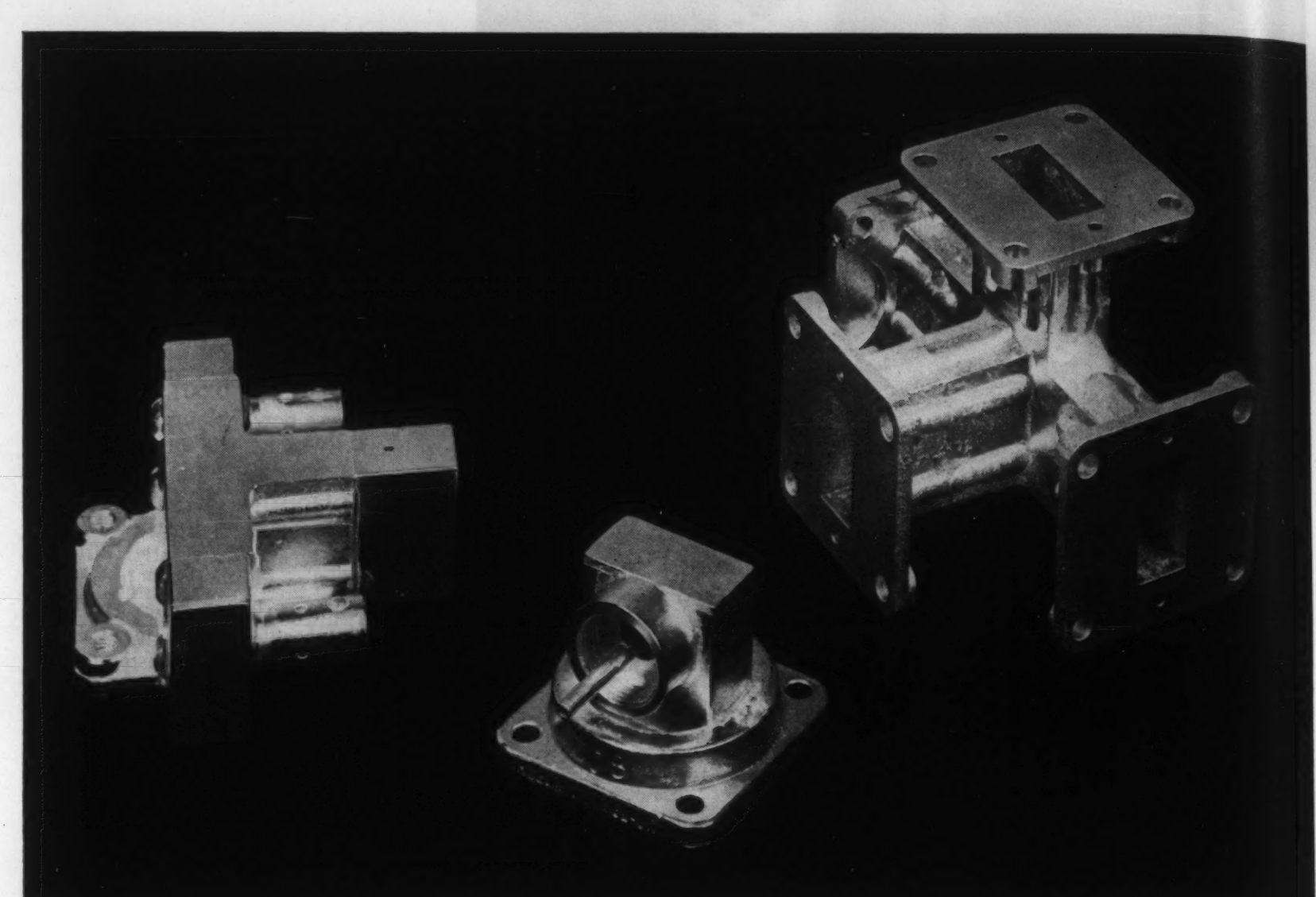
Rhodium can be plated directly over silver, nickel or gold. It can also be plated over copper, brass, steel and other metals and alloys, but it is advisable to first apply a flash plate of silver, nickel or gold to prevent a build-up of foreign metals in the rhodium bath. In many cases the base plate determines the minimum allowable thickness of rhodium, and this should be considered to reduce the production cost per unit. Where rhodium is used for its hardness and wear resistance, nickel has been found to be the best base. Nickel can be used in some electrical components but generally silver, gold or hard gold is preferable.

Properties and Applications

The accompanying table lists the principal properties of heavy electroplated rhodium. The hardness of rhodium is in the upper range of hard chromium. Rhodium is more corrosion resistant than gold and platinum and is one of the most inert of all metals. Its electrical resistivity (less than that of either platinum or palladium) is 4.51×10^{-6} ohm-cm.

The complete absence of tarnish and oxide on a rhodium surface has led many electrical and electronic manufacturers to employ electroplated rhodium as a contact surface where low and perfectly stable contact resistance is necessary. Oxide and sulfide films normally present on contact metals form nonohmic contacts that give partial rectification of signals and introduce spurious signals into the circuit.

Partial rectification has been a particularly vexing problem to many engineers working with input circuits for very high and ultra high frequencies. Heavy rhodium plated contacts



Waveguides and other electronic components are one of the most important fields for rhodium plating.

have solved many of these problems, since rhodium-to-rhodium contacts maintain an ohmic contact resistance under all atmospheric conditions. Electroplated rhodium is now used as a contact surface on many co-axial relays, R. F. relays, inductance tuners and tuned lines. Rhodium plated tuned lines, in addition, allow contact to low voltage-high current points.

Alarms and safety devices, although remaining inactive for long periods of time, often in corrosive atmospheres must make positive contact when energized. Normally, contacts have to be scraped and cleaned frequently to keep them in proper working conditions. Rhodium plated contacts, however, used in boiler feed alarms, burgler alarms and interlocks, remain bright, clean and free of built-up corrosion products.

Moving electrical contacts such as slip rings, special purpose commutators and rotary switches require a contact surface that is ohmic, smooth, extremely hard and anti-galling. Heavy electroplated rhodium meets all of these requirements and is now applied to many of these components. It exhibits excellent anti-galling properties, has a low torque build-up, and gives long service life. The hardness of electroplated rhodium—800 Vickers D.P.H.—insures that even 0.0001-in. coatings will outlast other metals and alloys under conditions of high pressure or high rotational speeds.

Certain slip rings are required to carry step voltages or complex, information-carrying waves. These waves must be transferred unchanged through the contact junction; otherwise the information they carry will be distorted or completely changed in character. Noise voltage of a metal-to-metal contact and partial rectification are among the chief factors in distorting a waveform. Rhodium is advantageously used on these components, as it generates a very low R.M.S. noise voltage and can transmit a signal substantially unchanged in form.

To date rhodium has not been thoroughly investigated as a lining for pharmaceutical and other high purity chemical process equipment. Nor has it been extensively applied to materials handling of corrosive agents. It has, however, been used successfully on valves, gages and flow meters in high purity water systems. With the new techniques for plating crack free heavy rhodium deposits, it will certainly become an important specialty anti-corrosive coating in systems handling compounds that are poisoned by fractional parts per million of copper, iron and other cations.

Plating Processes

Techniques for plating heavy deposits of rhodium, while demanding extreme cleanliness, are quite straightforward and less exacting than many types of electroplating. Tanks for rhodium plating are constructed of pyrex, plastic or polyvinyl chloride elastomer lined stainless steel. Heating should be indirect, although fused silica immersion heaters can be employed. Agitation, when required, can be manual agitation of the work or by means of glass or polyvinyl chloride elastomer coated impellors.

Articles for heavy rhodium plating are cleaned and activated by standard plating techniques. Great care, however, must be taken in the cleaning

Bendix Aviation Co. uses small individually controlled tanks in a semi-production plating unit.

cycle to insure that the work is chemically clean. Rhodium baths are easily contaminated and result in dull rough deposits or no deposits at all. Partial or uneven activation must also be guarded against, since rhodium once plated cannot be stripped. Plating rejects, therefore, must be kept to an absolute minimum. This is particularly true when parts prior to plating are valued at several hundred dollars.

The composition of the rhodium bath for heavy plating and the conditions of operation vary widely with the shape of the part to be plated and the desired thickness to be applied. Generally, baths are specially made for each particular job. For plating 0.00001 to 0.001 in., the range of rhodium metal content of the bath is 8 to 40 gm per gal. The metal is added to the solution as the sulfate complex. Phosphate complexes and mixed baths have not produced high quality bright and crack-free deposits. The range of acid concentration for the bath is 50 to 555 cc of C.P. sulfuric acid per gal. Other operating conditions are:

Temperature	100 to 120 F
Agitation	10 to 100 ft per min across the face of the work
Plating time	1 to 60 min
Current density	5 to 100 amps per sq ft

Insoluble platinum anodes are used. The anode to cathode ratio is not highly critical, since the throwing power of the bath is excellent. For blind holes or deep recesses, it is sometimes necessary to use inside platinum anodes and to pump the solution through or against the work surface.

The control of a heavy rhodium plating bath is not difficult. Where close tolerance thickness specifications must be met, it is advisable to use an ampere-hour meter to record the quantity of rhodium deposited. With such a meter and close chemical control of the solution, deposits can be accurate to within 5% of any desired thickness. For thin deposits and less critical work, it is possible to rely on automatic timers or easily read clocks and ammeters.

The rhodium content of the bath is controlled by colorimetric or standard gravimetric methods, and the acid concentration is checked by titration. The rhodium bath is comparatively simple in composition, as it contains only rhodium, sulfate and hydrogen ions and there are no complicating factors in chemical analysis.

Rhodium Thickness Requirements

Application	Thickness
Decorative Finish	1 to 5 millionths of an in.
Tarnish Protection	5 to 10 millionths of an in.
Light Duty Electrical Contacts	15 to 20 millionths of an in.
Heavy Duty Electrical Contacts	0.0001 in.
Infrequently Used Contacts	0.0001 in.
Corrosion Protection	10 millionths of an in. and over
Severe Corrosive Conditions	20 millionths of an in. and over
Severe Wear Electrical Contacts	0.00025 in.

Properties of Electroplated Rhodium

PHYSICAL

General: Brilliant, white untarnishable member of the platinum group metals
Specific Gravity: 12.44
Melting Point: 3570 F
Boiling Point: about 7800 F
Specific Heat (68 F): 0.0604 Btu/lb/F
Thermal Conductivity 64.4 F: 50.8 Btu/sq ft/ft/hr/F
Coef of Linear Expansion: 0.0000046 F (32 to 212 F)
Modulus of Elasticity under Tension: 40×10^6 psi

ELECTRICAL

Resistivity (64.4 F): 4.51×10^{-6} ohm-cm
Temp Coef of Resistance (32 to 212 F): 0.00242/F
Relative Attenuation (Copper 1): 1.46
Specific Magnetic Susceptibility (64.4 F): 1.11×10^{-6}

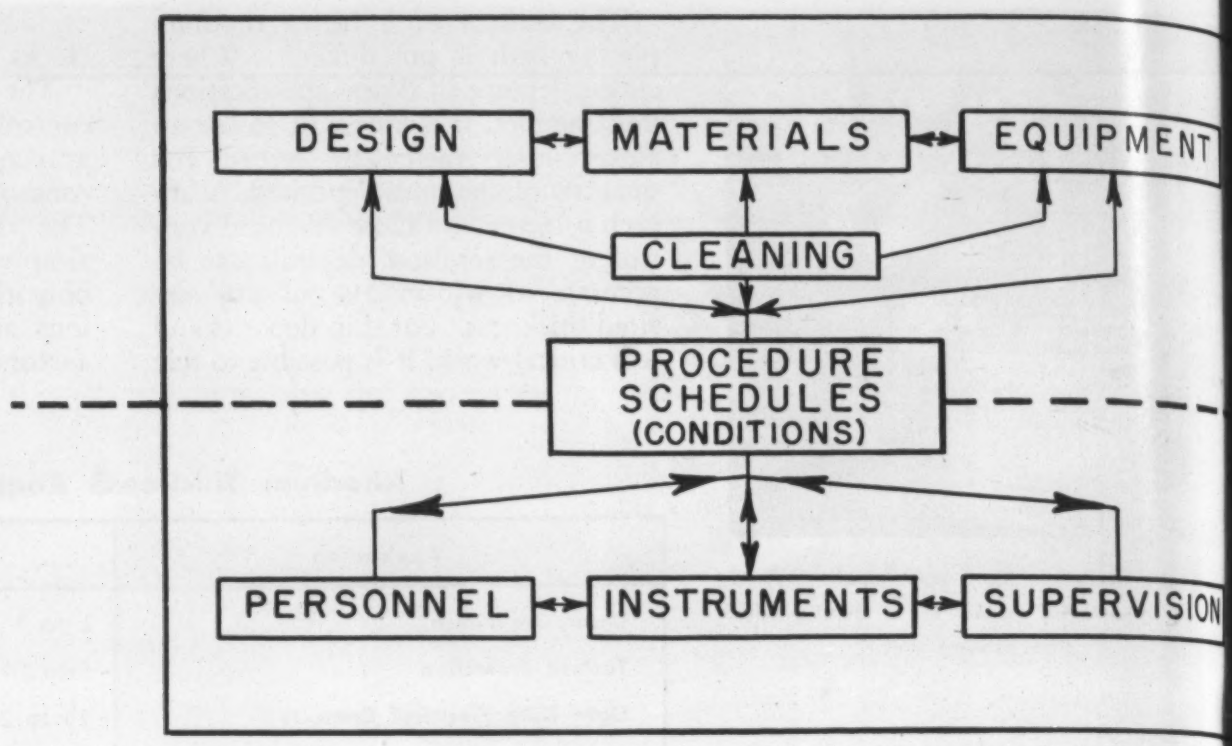
HARDNESS

775 to 820 Vickers

CORROSION RESISTANCE

Resistant to boiling Aqua Regia, nitric acid, sulfuric acid, phosphoric acid, hydrochloric acid, hydrofluoric acid.
Resistant to chlorine, bromine, hydrogen sulfide, dry iodine.
Resistant to marine atmospheres, industrial atmosphere.
Resistant to ferric chloride, aluminum sulfate, copper sulfate and other acid salt solutions.

Advanced Planning Leads to



● IN CERTAIN INSTANCES it is highly desirable that better methods of detecting poorly formed welds be available. However, in the broad sense, the important industrial problem is not the availability of means for the detection of poorly formed welds; it is that of consistently producing quality welds which do not require questioning. Quality welds have properties above the rationally established minimum acceptable requirements.

By the time the production welds have been formed, most of the expense of the product has already been incurred. There should be no need for mass testing, scrapping or salvage and repair in our routine production work. Instead, an attempt should always be made to meet the minimum quality requirements, which should be established in advance of production as standards for each metal-product combination.

Design Considerations

Consistent spotwelding begins with the design of the product or part. Unless the parts are properly proportioned and disposed to provide access of the current and force transmitting electrodes, with adequate edge distances and overlaps, it will be from impractical to impossible for the production line to produce acceptably consistant quality welds.

The consequences of using inadequate edge distances are overheating, expulsion of metal, spreading, and even cracking of the metal edges surrounding the spot. If accessibility has not been designed into the part, it may be necessary to use flexible offset electrodes. These, however, deflect under load to produce side stresses which, in turn, may distort or crack the metal. They may even fail to transmit the necessary force for the formation of a sound weld.

While it is usually possible to make welds under edge conditions other than those which may be specified as standard, such welding procedures require special setups for each part, and sometimes may involve the use of special, more expensive, equipment such as pulsation welding controls or slope control. These items may be locally unavailable. As a minimum they may add unnecessarily to production expense and retard the rate of production.

Therefore, both the quality control and the production personnel concerned with spotwelding are justified, in fact are obligated, to reject grossly inadequately designed parts before the spotwelding is started. To eliminate costly wastage it is obvious that close cooperation should always be maintained between those planning and designing spotwelded products and the production welding departments. One often-present problem is that a design which is suitable for equipment in one plant may be inadequate for use on equipment in a different plant of the same organization. The engineer must design for existing equipment, or else the necessary equipment must be provided for the production of new, different or more exacting designs.

Selection of Materials

A vital influencing factor in obtaining consistent spot welds is the selection and specification of the material from which the part is to be built. This fact is too often overlooked. Different materials require different detail welding procedures, and some materials are more easily spot welded than others.

Consistent spotwelding also depends upon the uniformity of materials being welded. Using cleaned carbon steel as an example, the properties of the final single-impulse spotweld that has been properly proportioned and produced reasonably free from cracking and porosity, is a function of material thickness, its pre-welded tensile strength, the material composition and the weld diameter. Of these four variables only the weld diameter is controllable by the spotwelding personnel. This demonstrates how necessary it is to maintain continuous control over the uniformity of quality of the base metal furnished to spotwelding machines. A qualification on the uniqueness of controlling weld diameter alone is that, at the same time, control must be maintained over weld penetration, usually between the limits of 30 to 80% of the thinner outer sheet.

The strength of a weld, particularly under direct tension components,

Consistent, High Quality Spotwelds

Success of such a planned program depends on continuous cooperation between engineering, production and quality control departments

by J. HEUSCHKEL, Research Laboratories, Westinghouse Electric Corp.

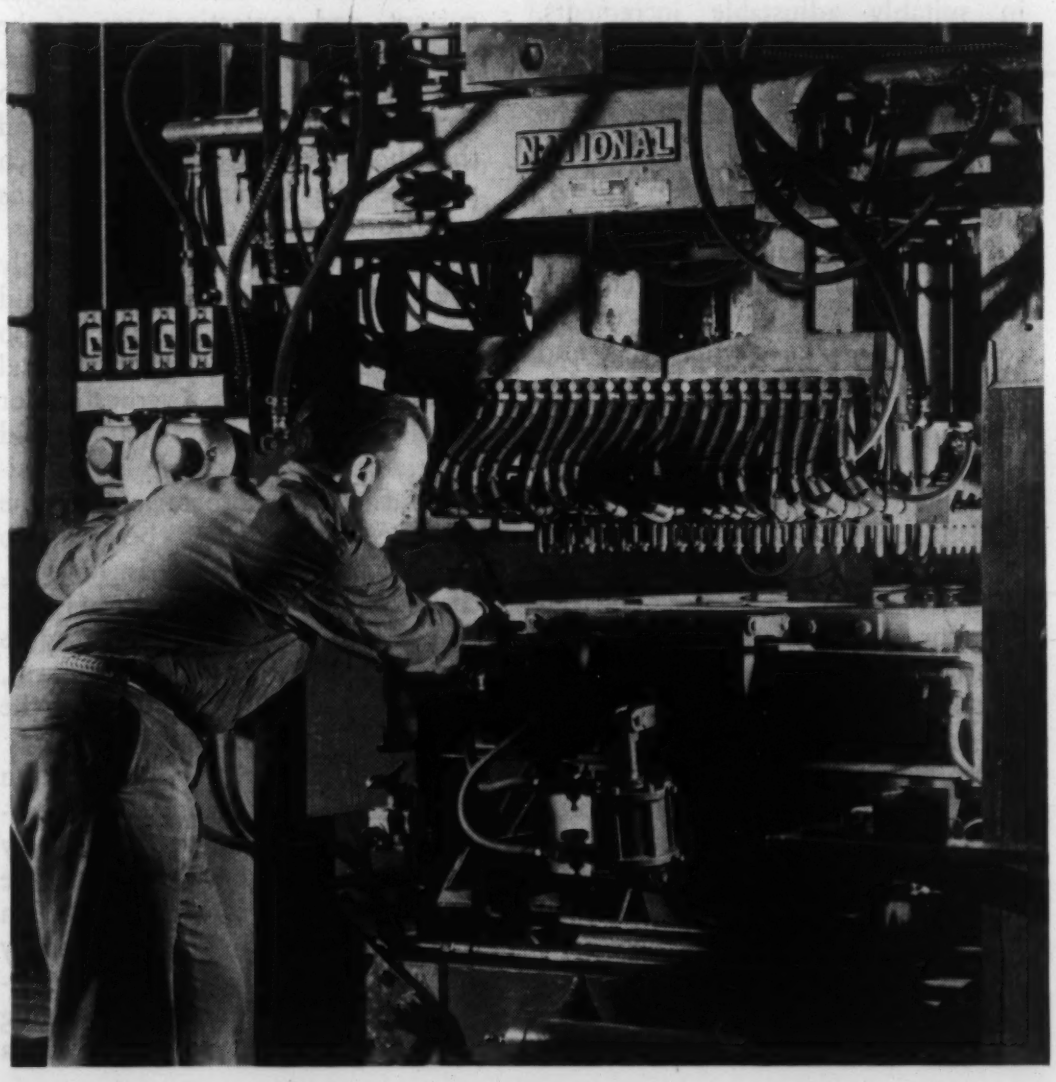
is very strongly influenced by composition and temper of the material, and it is for this reason that the satisfactory upper limit for single impulse conventional spotwelding procedures on carbon steels are limited to 0.15% max carbon content.

Surface cleanliness is also a variable. When it is difficult to secure delivery on materials, there is often a tendency to accept metals that vary considerably in analysis, thickness, strength and surface conditions. While it may be possible to weld any particular individual lot of this material, the random supplying of such storage and production mixed materials to spotwelding machines makes it difficult or impractical to maintain consistent welds. This again emphasizes need for continuous cooperation between the production welding people, quality control, and the purchasing departments. Surfaces to be spotwelded should be clean and laboratory equipment is available to evaluate cleanliness.

The same general principles apply to every metal. For example, several aluminum alloys are being satisfactorily spotwelded in mass production to aircraft quality requirements, but this does not mean that all aluminum alloys can be welded with the same procedures or that the aluminum spotwelding and cleaning problems may be dismissed with impunity. Quality production of spotwelded aluminum parts requires even closer control of material grade, surface cleanliness, adherence to welding schedules and thorough maintenance of properly selected equipment.

Occasionally, industry is faced with the welding of special metal and alloys. Often firm advance knowledge on the proper procedures to use for these metals is not available. It may not even be known whether their thermal and metallurgical reactions are suitable for spotwelding

Careful advance planning is largely responsible for the uniform, high quality spot welds obtained with this hydromatic spot welder.



equipment existing in any particular plant. In a few instances, such materials have been specified for use in some particular product on the assumption that they could be satisfactorily welded, and only later was it found in production that the welding limits were so narrow that it was impractical to fabricate the parts on the production line involved.

To avoid such costly and confusing conditions, it is sound policy to insist that proof-tested in-plant schedules on the material in question be capable of producing welds having adequate properties before the parts are put into production. While this procedure involves a certain amount of expense and may cause initial delays, under a properly organized plan, initial delays can be minimized and far more costly production difficulties and delays can be avoided. Again, this is an instance where close cooperation is required between the designing, engineering and production units of an organization.

Equipment

Consistent spotwelding depends upon adequacy and consistency of operation of the welding equipment. Equipment used must be capable of producing the necessary forces, currents, voltages and current flow times in suitably adjustable increments. Electrodes should be of the proper composition and must be adequately cooled, shaped and maintained. The electrode configuration is just as important as other variables. Voltage and air line variations cause output variations and hence, if uncompensated, produce inconsistent welds. A common fault is use of too light equipment on heavy materials and too heavy equipment on light materials.

Personnel

Consistent spotwelding is, in the final analysis, a matter of education. It is a matter of teamwork between operator, set-up man (if used), inspection, quality control, engineering, purchasing and supervision. There are many practical combinations under which the required minimum quality can be assured. In some plants the operator is wholly responsible. This is effective only with the best of operators, with suitable experience. Others use set-up men, the operators being mere manipulators, not permitted to adjust machine or controls.

The items of design, materials, equipment and personnel are given attention prior to discussing the more conventional welding variables to emphasize their importance in the final factor of uniformity of spotweld properties.

Procedures

Consistent spotwelding leans heavily on the selection and use of a uniform procedure. If all the conditions are always within suitable limits, the welds will always be good. For a given suitable material and design the quality of the welding is determined wholly by the manner in which mechanical and electrical energy is applied to the electrodes. Both the current and force magnitudes are important, but localized densities are even more important. These depend upon the contacting area of the electrodes.

One of the key problems in production of high quality spotwelds is the fact that the mechanical parts of the machine and of the electrical circuit may go through all of the necessary motions, and yet either no weld is formed or the weld has unsatisfactory characteristics. It has been shown that there are working limits within which force, magnitude of current, time duration of flow of current, and contacting area of the electrodes may vary and yet satisfactory welds will be produced. In fact, fortunately, it has been found that those welding conditions which produce the better strength welds are also the more consistent.

The forces used may ordinarily cover a fairly large range, and should be established first. The use of too low force will produce internal metal expulsion or surface overheating or expulsion. The results are rapid deterioration of electrode and possibly cracked and porous welds. If the force is permitted to become too high, contact resistance is lowered, contact area of the electrodes is generally increased, current density is decreased and, for a fixed current, weld strength becomes less and the welds are inconsistent.

Thus, there is truly an optimum force range for each metal composition-thickness condition. For ordinary metals it is satisfactory to use the statically applied force as a criterion of uniformity. This is best done by using a force bar type of gage between the electrodes. When welding metals such as aluminum with a double force system, the time of application of the forging force is often critical, and in such cases it is often necessary to check time of application of that force by use of a wire strain gage device attached to a brush oscillograph.

Follow-up of electrode is important, in some instances, to maintain uniformity of pressure. Laboratory devices have been built to demonstrate motion involved. Head inertia and friction are important factors with sensitive metals.

The size of the electrode-end contacting the work controls both pressure and current density and thus exerts as important an influence upon weld quality as the machines and electrical controls. Again, there is an optimum size, and electrodes should be continuously maintained to that size either by proper dressing in the machine or at periodic intervals at a central station.

Metals such as aluminum have a tendency to alloy on the surfaces of the work with copper from the electrodes. This introduces the problem of tip life, which varies with different electrical systems and may become a factor in choice of equipment or control systems. Cleanliness of the exterior surface is definitely a factor in improving tip life of any metal.

Time duration of the passage of welding current is another basic variable which influences weld strength. Again, best consistency is found, particularly for carbon steels, when the highest strength is also obtained. It has been found best not to try to make welds with too short times. The use of longer times permits distribution of heat and is a satisfactory way of compensating for shunting effect through previous welds.

It is impossible to detect the interior quality of the weld from external appearances. Where severe shunting exists, surface heating may produce a surface heating of the electrode and the illusion of a large weld nugget, whereas at the interface either small or no nuggets may be formed. Total joint strength is controlled by the rupture strength of the weaker weld. This emphasizes the need for consistency. By proper selection of welding time, it is possible to produce uniform welds in steel regardless of weld spacing, although it is not good economics to use more welds than are necessary. In fact, available data prove that the random formation of closely spaced welds may actually weaken

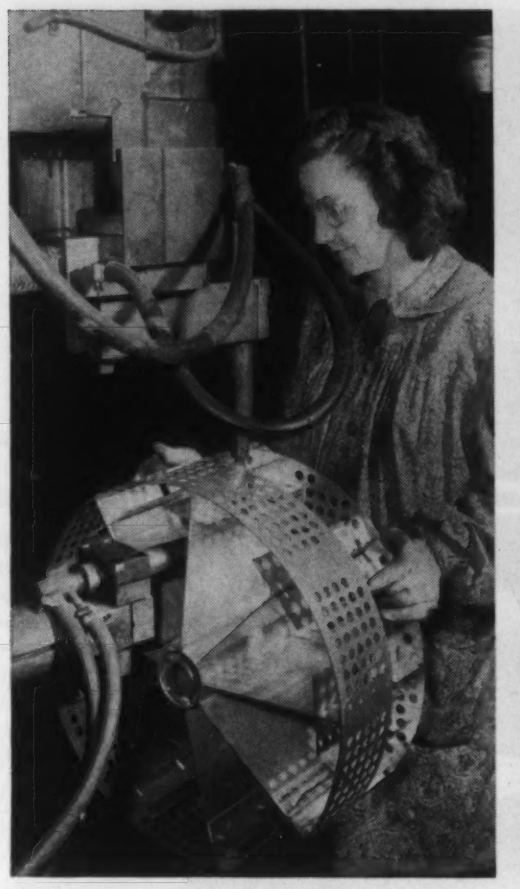
the part, that is, if a proper welding schedule is not being used.

Whether the weld is not formed at all, or is only partially formed, or is formed in such excessive size as to produce undesirable sheet separation or indentation or even cracking, is a function of both the total energy applied and the rate at which that energy was applied. For each welding time there is a minimum and maximum limit or permissible welding current, and for each welding current magnitude there is a permissible range of welding time. For any force, electrode configuration and material combination, the acceptable range of welding conditions may be plotted on a graph as a concave-up crescent where time is the abscissa and current the ordinate. Any point combination within this crescent is satisfactory. It is not necessary always to use exactly the same schedule, so long as the proper balance is maintained.

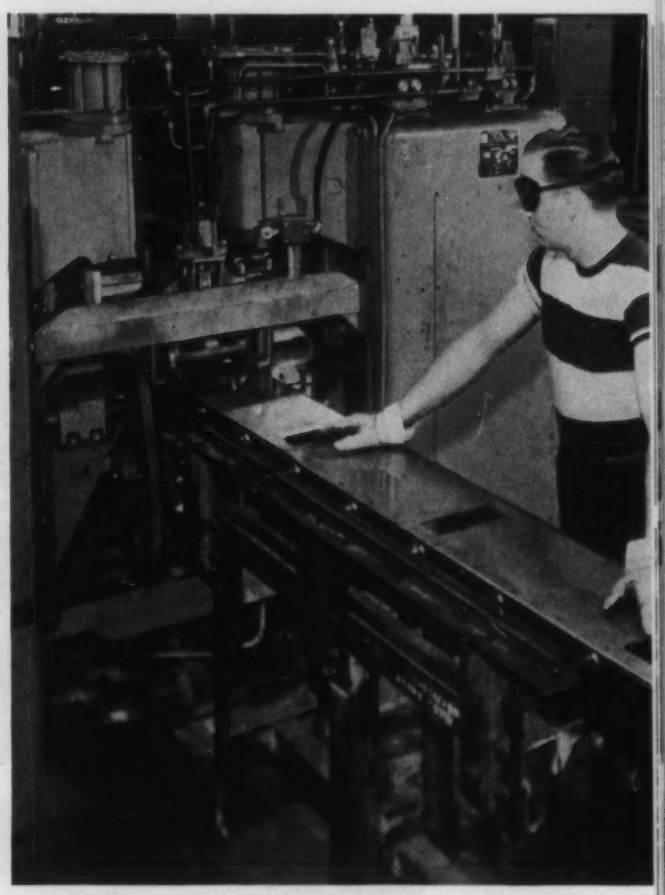
For any electrode configuration and composition, the amount of force required and the permissible current time limits are a function of material composition, thickness and temper, and influence the suitable crescent area. When using cold rolled material, it is ordinarily necessary to use higher forces and sometimes lower currents. Any particular schedule can be used for a slight variation in thickness range, but in general the magnitudes of the forces, currents, times and electrode sizes should increase with material thickness. By making these adjustments, it is possible to secure the same consistency in spotwelding heavy material as light. This maintenance of uniform consistency across the thickness scale cannot be secured by using inadequate equipment.

Relatively, spotwelds in thin sheets are large and spotwelds in heavy materials are small, even though the actual dimensions are in the reverse order. The diameter-to-thickness ratios range from about 10:1 down to 2:1. Also, in thin materials the molten nugget is very close to the electrode and the quench rate on thin materials is extremely rapid.

The motion of electrodes is another important variable; friction and inertia must be sufficiently low so that the electrodes follow up changes in the thickness dimension of parts as they are heated and subsequently cooled. Also, the approach velocity of the electrodes is a factor in maintenance of electrode configuration.



Spot welding soft drink dispenser components made of aluminum. (Reynolds Metals Co.)



If consistently high quality spot welds are assured, mass testing during production is not required.

Too slow approach velocity unnecessarily retards production; too rapid approach velocity mutilates the electrodes.

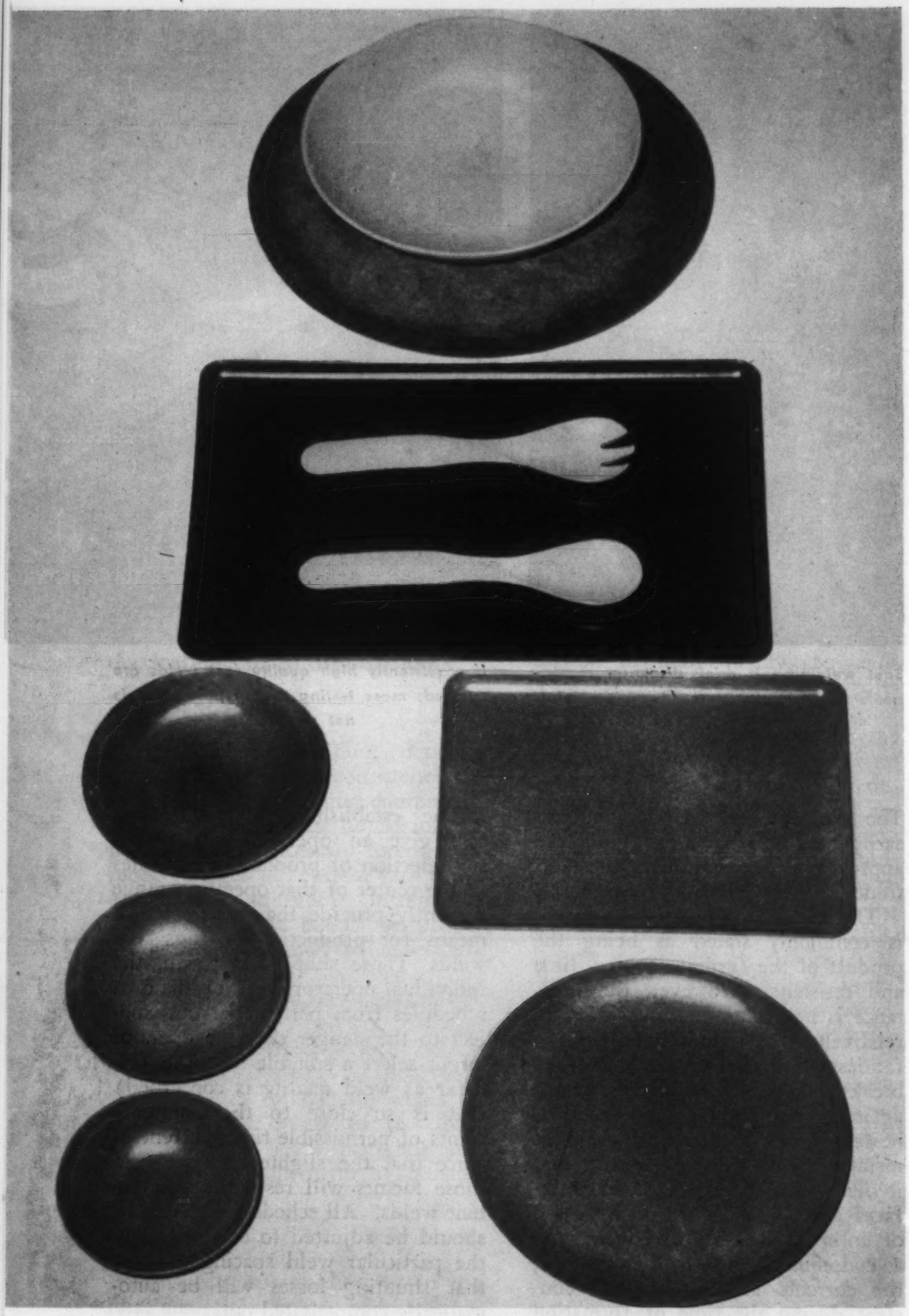
The heat applied to the spotweld is commonly stated as being the product of the current squared, time and resistance. However, the resistance is not constant. It varies from relatively high values initially to a far lesser value as contact resistance breaks down. It tends to increase again as the body of the metal is heated because thermal coefficients of metals increase with temperature and it then tends to reduce as the interfaces are eliminated through fusion or intimate mechanical contact. As a consequence of these variations, the currents are not actually constant during the time of formation of a weld. The commonly used RMS currents are only approximations of the true currents.

The equivalent total energy input can also be described as the product of current, voltage and time, but again this may vary in effectiveness. There is at this time no available instrument which simultaneously corrects for all the welding variables encountered, including those which change from weld to weld as electrodes change in configuration and material surfaces vary.

The establishment of schedules that give an operating range and the selection of production schedules in the center of that operating range presently provide the most practical means for production of consistent welds. Those shops that permit the individual operator to set up his own schedules from part to part are subject to the danger that the operator might select a suitable schedule (insofar as weld quality is concerned) that is so close to the boundary limits of permissible time, current or force that the slightest variation in those factors will result in inconsistent welds. All schedules, of course, should be adjusted to correspond to the particular weld spacing used so that shunting losses will be automatically compensated out.

The production problem is one of continuous surveillance over the actual variations involved. Consistent spotwelds are produced by the intelligent coordination of design, materials, equipment, personnel and procedure. This is not a simple task. A five-variable system must have all values under very close control before one can hope to secure uniformity. Spotwelding in one sense is a victim of its own virtues. It appears to be such a simple operation that it has been too often dismissed as such.

by JOHN STARR



***TYPICAL PRODUCTS** of company are shown above. Wood flour tableware features thin walls, glossy surfaces, color effects and moisture resistance, plus shock resistance superior to that of plastic and ceramic products.*

New Wood Flour Moldings Compete with Plastics

Moldings using only 20% resin binder have good finish and high shock resistance. They can replace, even surpass, more costly plastics for many applications.

● WOOD FLOUR, A MATERIAL produced by granulating and pulverizing wood scraps, has been used for many years as a "cheapener" or "bulking agent" in plastic molding compositions, caulking compounds, etc. But, until recently, efforts to make full use of the inherent physical properties of the cellulose fibers in wood flour were unsuccessful because it seemed to be impossible to reunite the fibers as skillfully as they were initially bonded by Mother Nature.

Now, thanks to a new processing technique developed by Ability Products Co. at Pasadena, Calif., wood flour is being converted into moldings with many qualities that are actually superior to the properties of natural wood materials.

These moldings are known as "Flintwood" products, and could

have virtually any of the contours and dimensions of all the articles that are now being compression-molded. However, most Flintwood products at present can be classed as tableware.

Such tableware has the thin walls, glassy surfaces, color effects, and moisture resistance of top-quality plastics and ceramics; yet it can withstand shocks and blows that would shatter plastic or ceramic tableware, which costs much more money.

Raw Materials Used

Wood flour for Flintwood tableware is purchased by Ability Products from standard sources of plastic filler materials. To produce a molding compound, 80 parts flour are mixed by weight with 20 parts urea-formaldehyde resin.

The flour-resin ratio in this case is especially important because it explains the unusual physical properties of Flintwood products. Previously-used molding compounds containing wood flour lacked similar properties, because they comprised greater quantities of resin than wood. In addition to being relatively expensive, moldings with a predominant quantity of resin tend to inherit the physical properties of the resin.

Monsanto Chemical Co.'s Lauxite UF-71 resin proved to be an ideal adhesive for bonding wood flour. First, it can be obtained as a heat-fusible powder; yet it is a thermosetting resin and, therefore, cannot be resoftened with heat once it has been molded. Second, it is one of the few plastic resins that can be pigmented with many light colors without danger of eventual fading in the molded product. Finally, it is capable of producing adhesive bonds that are stronger than the bonds in natural wood, and it can insulate the particles in wood flour so that the latter will not be susceptible to moisture after they are bonded.

Processing

The raw materials, including any desired pigments, are mixed prior to molding operations by means of a centrifugal machine. The quantities of mix that are required to mold individual products are then hand-loaded in the female cavities of a mold mounted on a compression press. Machined-steel molds are used in this work, since less expensive units would not meet the company's current production requirements.

The molding materials are heated to a 325 F as the press is closed. The compressive forces then exerted range from 2500 to 3000 psi, depending on the dimensions of the article being produced, and the average molding cycle is 4 min. Flash removal is the only additional processing operation required after the molding cycle is complete.

About 2 to 5% of the products to date have been rejected because of various defects, most of which are attributable to the inadequate bonding of wood materials. In view of the many "unpredictable" factors known to affect molding production, such as atmospheric conditions, mechanical failures, and mistakes in the compounding of materials, this reject rate is not considered to indicate a faulty process.

Other Process Applications

As a method of reclaiming scrap wood materials, this process should find a vast number of new applications by virtue of its ability to reduce the cost and improve the quality of many types of compression moldings. Simultaneously, it seems more than likely that slight variations in the basic process can be used to facilitate the recovery of many scrap materials other than wood. For example:

1. Scraps of leather, converted into a suitable flour, can probably be rebound with elastomeric resins in the manufacture of moldings or stock materials with many of the physical properties of natural leathers.

2. Ferromagnetic metal powders, properly dispersed in thermosetting resin binders, could probably be used to mold permanent magnets with minimum brittleness and maximum resistance to corrosion.

How a Problem Was Solved

Formerly, the mixing operation was the main hurdle in the way of wood flour moldings. There seemed to be no feasible method of dispersing a small quantity of *liquid* binder through a molding compound in a manner that would assure satisfactory adhesion of all wood particles. Successful adoption of a more easily dispersed *powder*-type adhesive by Carl Reininger, of Ability Products, removed this hurdle.

***WOOD FLOUR** mixed with 20% thermosetting resin as binder is the raw material for compression molded products having properties actually superior to those of natural wood.*

***SUCCESSFUL COMPRESSION MOLDINGS** of 80% wood flour had to wait for an improved method of dispersing bonding resin through flour. The answer was a powder-type adhesive.*

***LOW REJECT RATE** of 2 to 5% has been achieved by Ability Products Co. Rejects such as that shown above are attributed to inadequate bonding, a problem which, however, has been largely overcome.*

Salt Bath Case Hardening with Molybdenum and Tungsten

—A Correlated Abstract*

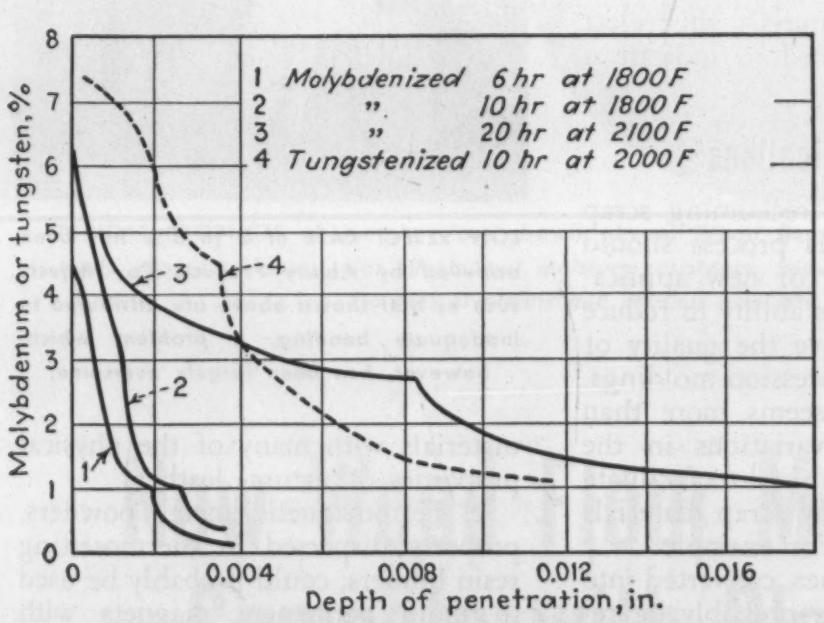
From Germany come reports of recent developments for improving the surface properties of irons and steels by increasing the tungsten or molybdenum content of the surface layers. . .

● VARIOUS METHODS OF enriching the surface layers of irons and steels to improve their properties have been in common use for a number of years. Most of these involve the use of carbon or nitrogen, although chromizing and siliconizing have found commercial application in recent years.

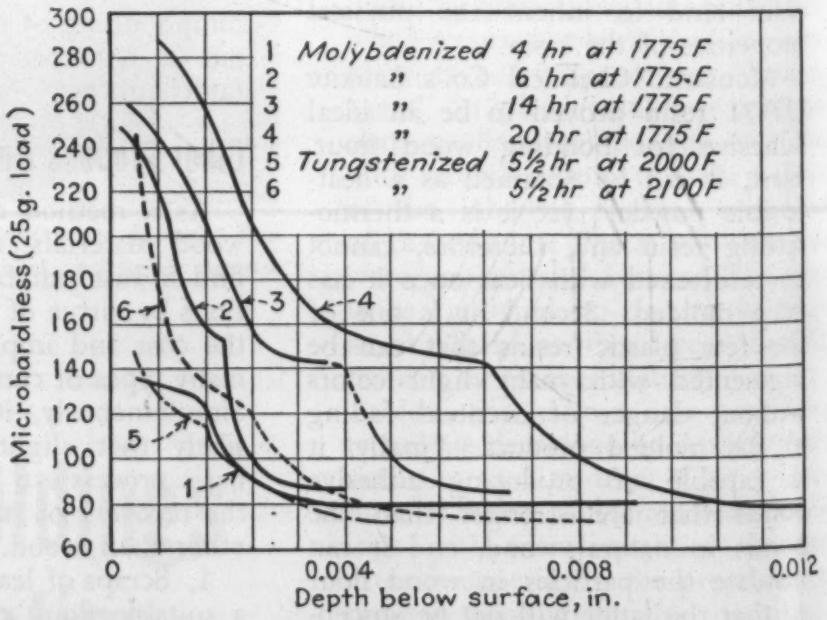
Molybdenum and tungsten are also proving to have interesting potentialities for case hardening. Recent investigations in Europe point to the possibilities of increasing the tungsten or molybdenum content of the surface layers of mild steel and, in effect, obtaining a clad steel. Such a steel can be carburized or nitrided for increased hardness or siliconized for increased corrosion resistance. The surface regions of austenitic chromium-nickel steels can also be modified by the tungstenizing or molybdenizing treatment.

In the use of tungsten and molybdenum, the reactions involve not only the deposition of the metal on the surface but its subsequent diffusion. Rates of diffusion of tungsten and molybdenum into iron have been determined at various times, and the results indicate that these rates are lower than those of carbon, nitrogen, silicon and aluminum but higher than that of chromium.

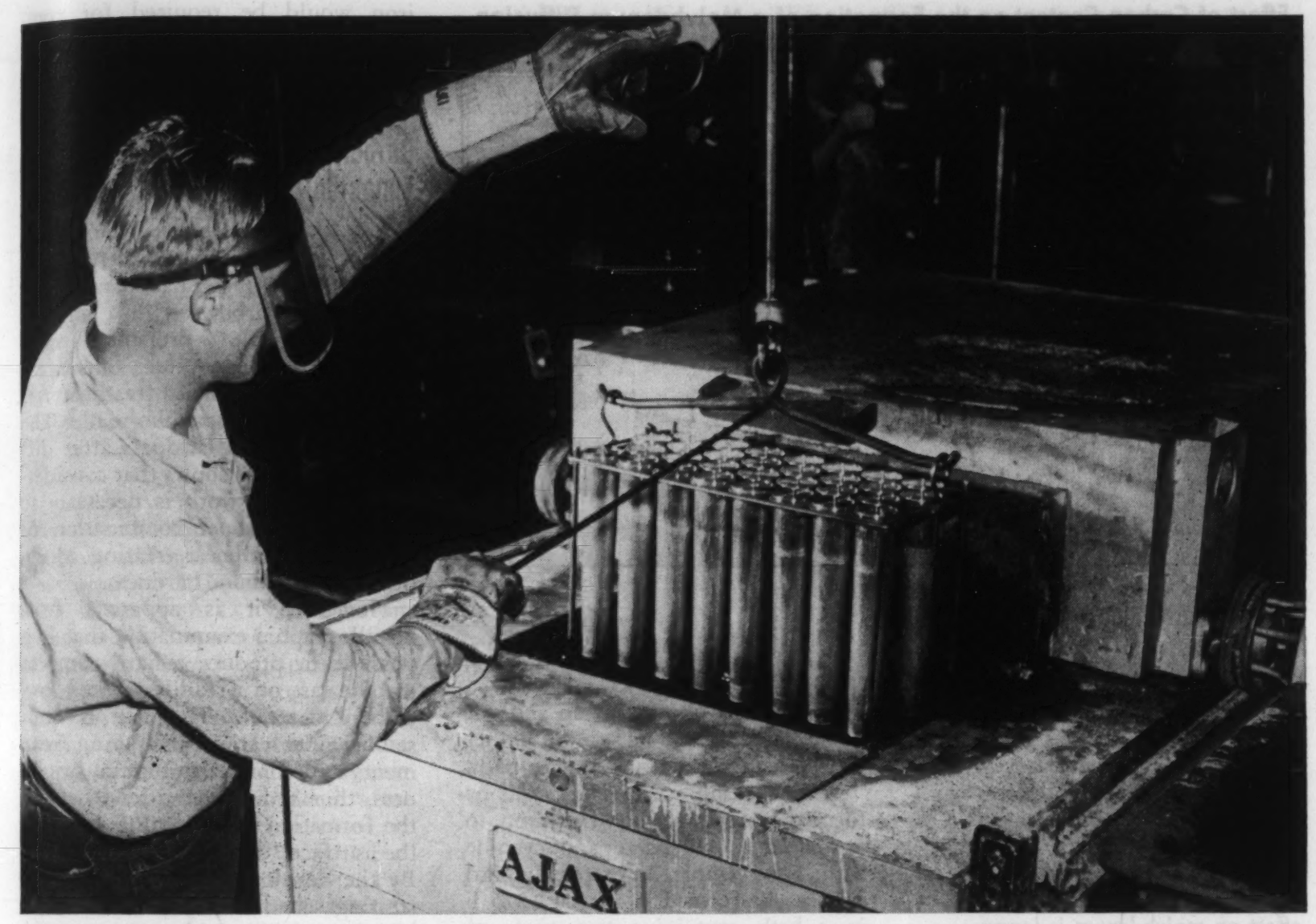
In the past, several methods have been employed to deposit the tungsten or molybdenum on the metallic surface in a form suitable for subsequent diffusion. These include cementation with a powder, vapor phase deposition, and reduction of



Molybdenum or tungsten content of the diffusion zone after salt bath treatment of iron.



Relationship between hardness and depth of penetration of molybdenum or tungsten into iron.



Although an enclosed liquid bath would be required for molybdenizing or tungstenizing, subsequent carburization could be done in conventional equipment. (Ajax Electric Co., Inc.)

molybdenum oxide with hydrogen in contact with the iron. It is this latter experiment that led to the investigation of molten salt baths for the purpose.

Salt Bath Treatment of Iron

The applicability of salt baths is based on the fact that at suitably elevated temperatures the alkali tungstates and molybdates are reduced to metal by hydrogen. In the presence of iron, the reaction can be accomplished at somewhat lower temperatures and confined to a controlled separation of molybdenum or tungsten at the surface of the iron. In this reaction, moreover, the pure metals are not obtained, but, instead, the elements alloy with the iron surface. To obtain layers of sufficient depth to be useful, subsequent diffusion of the molybdenum or tungsten into the iron is necessary and high temperatures are required to obtain suitable case depths at economical rates.

Thus, two opposing tendencies must be balanced to obtain suitable operating temperatures. They must be selected to prevent general decomposition of the bath (upper temperature limit) but also to obtain diffusion rates which are economical (lower temperature limit).

The molten salt bath is composed of sodium tungstate or molybdate. In an accompanying figure, curves 1 and 2 show the depth of penetration of molybdenum into iron at a temperature of 1800 F, at which general decomposition of the bath does not occur. Curve 3 shows greater diffusion at 2100 F but the molybdate bath decomposes rapidly at this temperature.

For practical purposes, molybdenizing in a salt bath should be done at temperatures below 1830 F. For tungstenizing, somewhat higher temperatures are permissible. Bath decomposition is the deciding factor. At 2100 F after 1½ hr, about 10% of the tungstate is reduced while under the same conditions over half of the molybdate is reduced. Thus, 1925 to 2000 F can be used for tungstenizing. In an accompanying figure, the hardness of molybdenized and tungstenized cases are given after various treatments.

Investigation of the action of other gases followed these experiments with hydrogen. Nitrogen could be used but the rate of reaction was too slow to be commercially practical. Ammonia reacted with sodium tungstate at so rapid a rate that the tungsten powder formed did not diffuse into the iron. On the other hand, ammonia could be used with molybdate. Rates of penetration using cracked ammonia were satisfactory, but those obtained with undecomposed ammonia were too low to be practical.

Salt Bath Treatment of Steel

The influence of carbon is important for the practical evaluation of the application of tungsten and

* From original papers by E. Fitzer, "Archiv fur das Eisenhuttenweser," Sept./Oct. 1952, pp 369-375, 377-382.

Effect of Carbon Content on the Formation of a Molybdenum-Diffusion Zone at 1800 F in a Sodium Molybdate Bath

Carbon Content of Sample, %	Treatment Time, Hr	Thickness of Carbide Case, In.	Thickness of Diffusion Layer, In.
0.0	6	—	0.0022
0.80	6	0.0004	0.0009
2.50	6	0.0002	(1)
0.0	14	—	0.0040
0.34	14	0.0002	0.0028
0.40	14	0.0002	0.0023
0.80	14	0.0006	0.0010
2.50	14	0.0004	(1)

(1) Not detected metallographically.

molybdenum for the surface improvement of steels. Cornelius and Bollenrath, using a cementation process, showed that carbon interferes with the diffusion of both elements. In steels containing more than 0.5% carbon, no tungsten diffusion occurs even after 200 hr at 2000 F. The effect on molybdenum is lower.

An accompanying table summarizing the results of molybdenum-diffusion tests in a salt bath shows that the diffusion was retarded by carbon, in agreement with the work mentioned above.

In contrast with the work of Cornelius and Bollenrath, however, a greater depth of penetration was achieved in a short time in the salt bath. This is attributed to the higher rate of surface reaction in the bath.

Similar results can be obtained by the exposure of carbon-free iron to a combined molybdate and cyanide bath. For example, an extremely hard case can be formed in 5 hr at 1875 F in a bath containing two parts of sodium molybdate and one part of potassium cyanide. The case depth under these conditions will be 0.0006 to 0.0008 in.

The shallow cases developed in these tests show the pronounced effect of carbon and indicate that diffusion of molybdenum or tungsten into low-carbon steel or carbon-free iron would be required for commercial application of the process, possibly with subsequent carburization of the diffusion layer.

Carburizing of Molybdenized and Tungstenized Cases

For this work, iron containing 0.03% carbon was tungstenized or molybdenized in salt baths and subsequently gas carburized in a mixture of 92 hydrogen-8% propane. A summary of the mean values of surface hardness after various treatments is given in an accompanying table. The great variation in hardness after different treatments shows that considerable additional work is necessary to develop the proper combination of carburizing and heat treating conditions for optimum hardness.

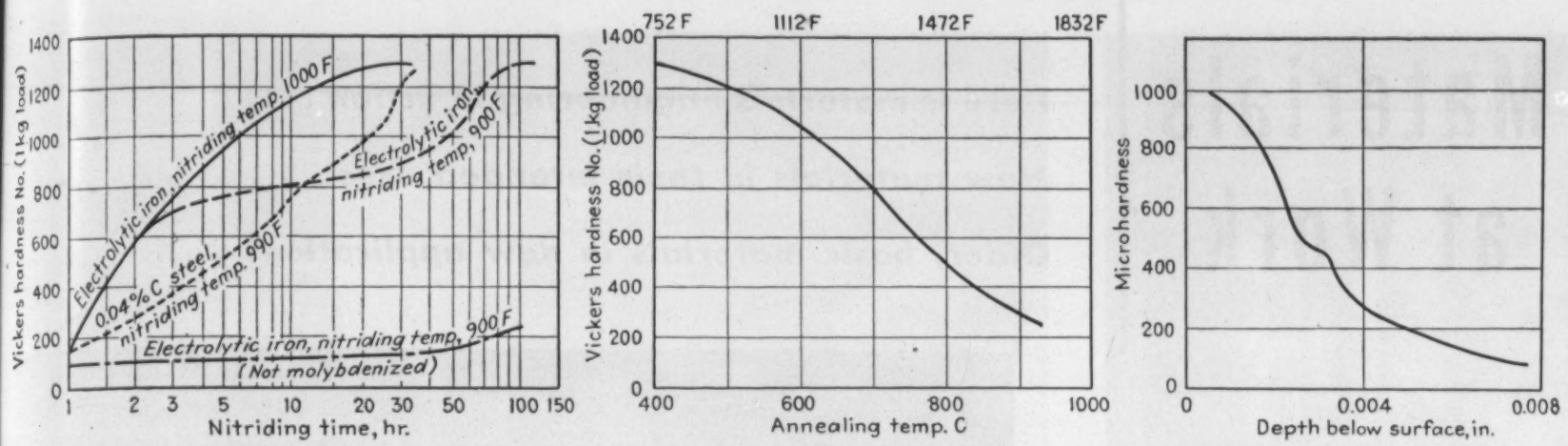
However, it is apparent from metallographic examination that it is possible to produce a hard complex carbide case on a readily worked low-carbon material. The case is quite stable under various tempering treatments and shows a minimum brittleness, thus reducing the tendency for the formation of hardening cracks in the surface during heat treatment. By the development of suitable heat treating schedules, an excellent combination of case and core properties could be obtained.

Nitriding of Molybdenized Cases

Molybdenum is frequently used as a constituent of nitriding steels. Therefore, the nitriding of the surface layer of molybdenized iron was investigated.

Effect of Carburizing and Heat Treatment on the Surface Hardness of Molybdenized and Tungstenized Iron

Liquid Bath Conditions		Diffusion Anneal		Depth of Ferritic Zone In.	Surface Hardness (Vickers-3 Kg Load)	Carburizing Conditions		Surface Hardness Vickers-3 Kg Load	
Liquid Bath	Temp, F	Time, Hr	Temp, F	Time, Hr			Temp, F	Time, Hr	After Furnace Cooling	After Quenching from 1750 F into Water
Sodium Molybdate	1830	6	—	—	0.0031	140	1760	6	280	650
	1830	6	—	—	0.0031	140	1760	10	350	1200
	1780	4	1830	10	0.0008	120	1760	6	220	730
	1780	4	1830	10	0.0008	120	1760	10	475	850
	1920	10	—	—	0.0117	137	1760	6	190	450
	1920	10	—	—	0.0117	137	1760	10	400	650
Sodium Tungstate	1830	5	—	—	0.0008	130	1830	5	330	—
Untreated Iron							1760	6	160	380
							1760	10	300	475


Vickers hardness No. (1 kg load)
Nitriding time, hr.
Electrolytic iron, nitriding temp. 1000 F
Electrolytic iron, nitriding temp. 900 F
0.04% C steel, nitriding temp. 990 F
Electrolytic iron, nitriding temp. 900 F (Not molybdenized)
752 F
1112 F
1472 F
1832 F
Annealing temp. C
Microhardness
Depth below surface, in.

Left: ***Increase in hardness of molybdenized iron with nitriding time. Center: Relationship between hardness and depth below surface for nitrided molybdenized iron. Right: Effect of annealing for 15 min on the surface hardness of a nitrided molybdenized iron.***

The relationship beween nitriding conditions and hardness can be determined from an accompanying figure. Work done by J. D. Venturini on various nitrided steels indicated that the highest Vickers hardness to be expected, using a 1 kg load, is about 1300. This figure was used as the criterion of complete hardening. On this basis, molybdenized electrolytic iron was completely nitrided after 4 hr annealing at 950 F followed by 25 hr nitriding at 1000 F. At a lower nitriding temperature (900 F), 100 hr were required to attain this surface hardness. Nitriding a 0.04% carbon steel after molybdenizing produced similar results. The nitriding of untreated electrolytic iron did not result in hardening effects such as those obtained in the presence of molybdenum.

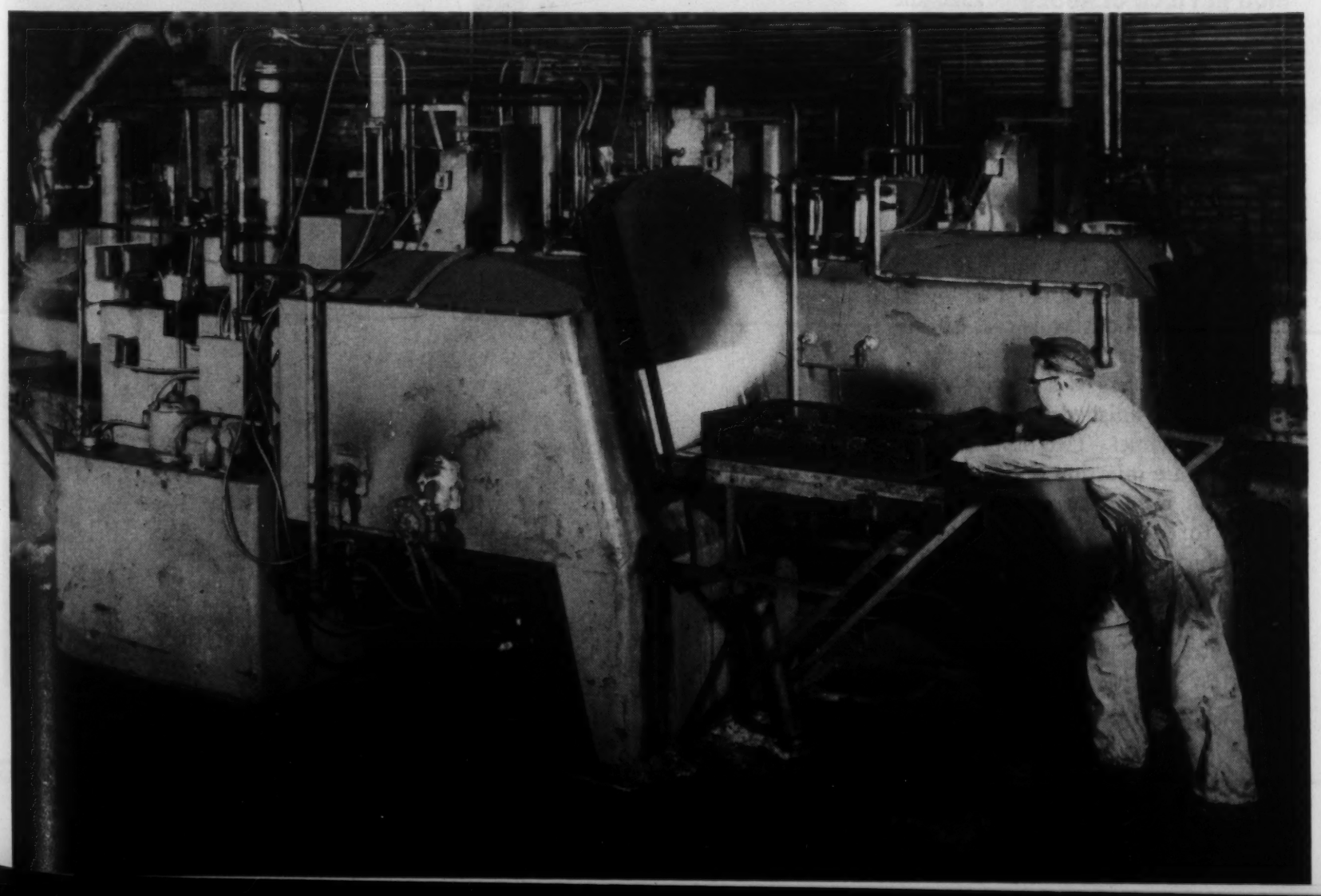
The maximum hardness in a nitrided molybdenized case produced in the manner described is confined to a rather shallow sub-surface zone and the hardness level drops quite rapidly below this zone. An accompanying graph shows the relationship of hardness to depth below the surface of a nitrided case.

The nitriding temperature must be carefully selected for best results. The use of high nitriding temperatures (above 950 F) leads to the formation of a brittle nitrided zone, an effect which is not found in material nitrided at lower temperatures.

Siliconizing of a Molybdenized Case

The acid resistance of 15% silicon cast iron can be improved by the addition of about 3% molybdenum. Folger and Hunziger found that equal resistance could be obtained with a molybdenum-bearing cast iron by siliconizing at 2000 F with silicon tetrachloride. The siliconizing of molybdenized irons prepared by the methods described previously have resulted in the development of a case as resistant to acid attack as the silicon-molybdenum cast iron mentioned.

Carburizing or nitriding of molybdenized surface layers can be done in gas atmosphere furnaces. (Ipsen Industries, Inc.)

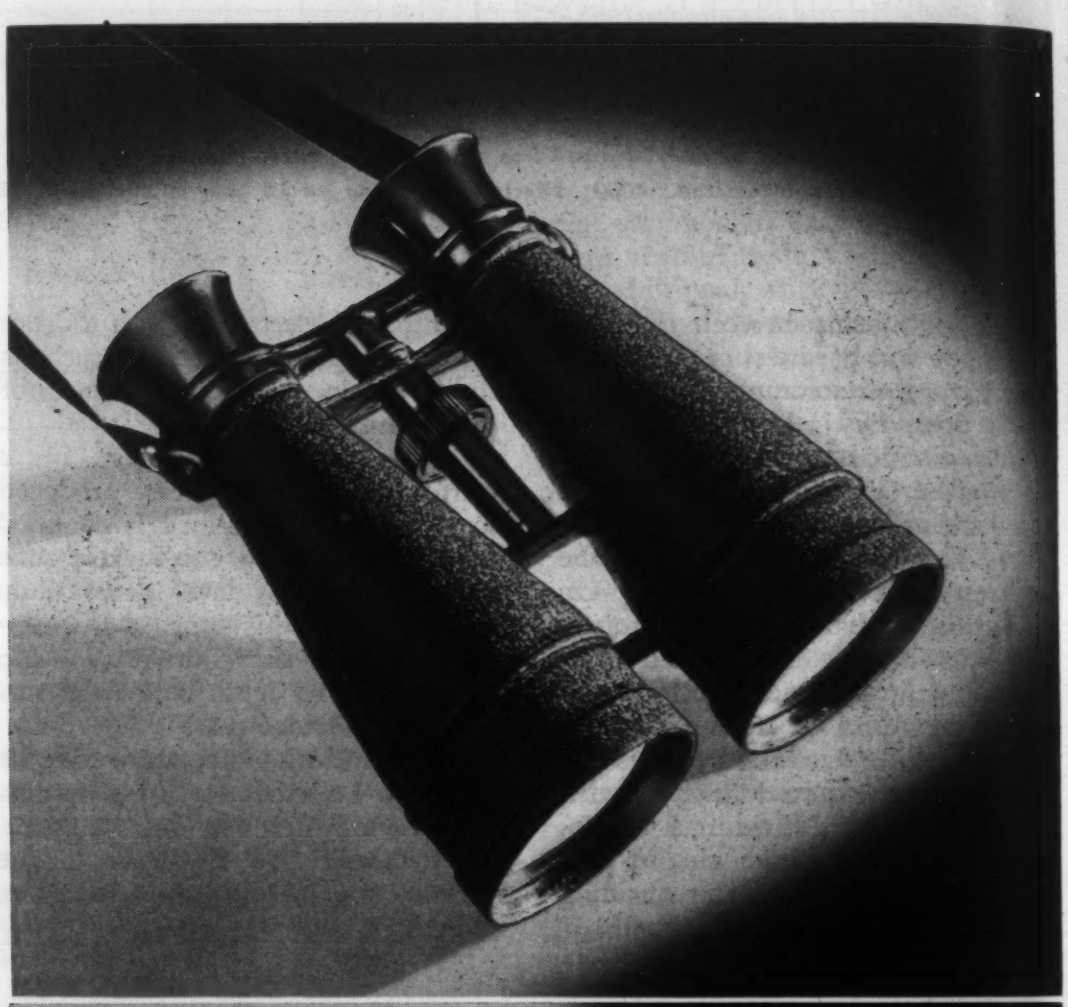


Materials at Work

Here is materials engineering in action . . .

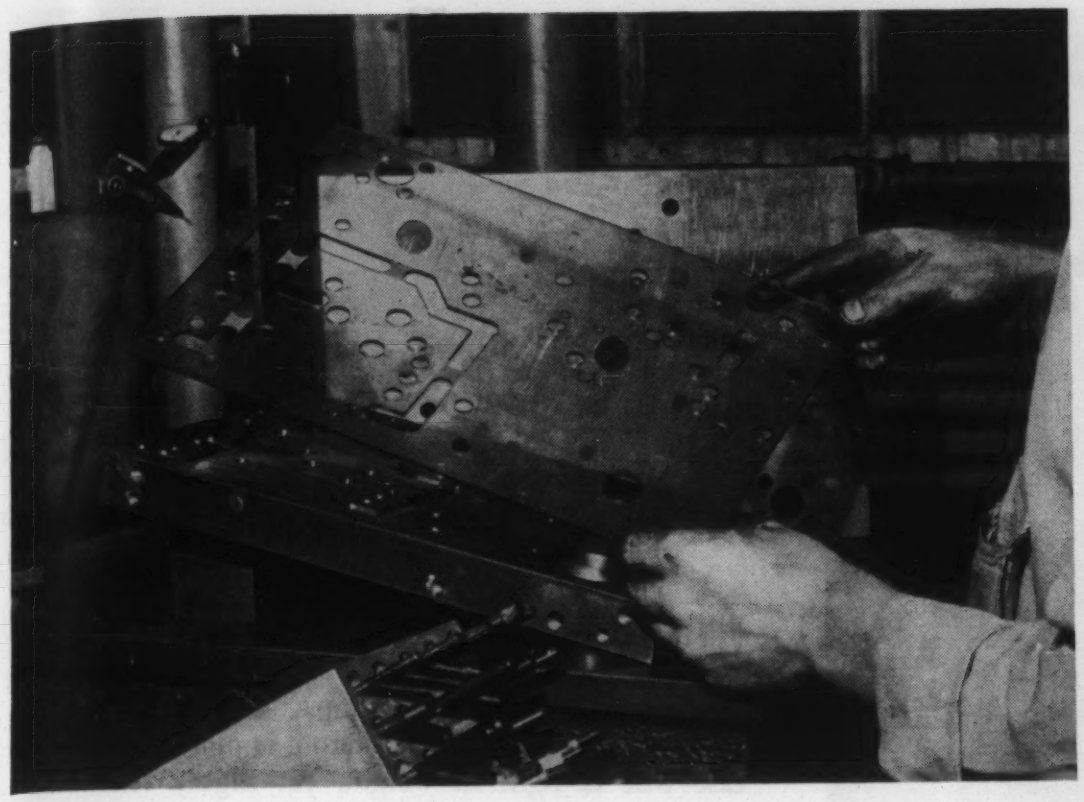
New materials in their intended uses . . .

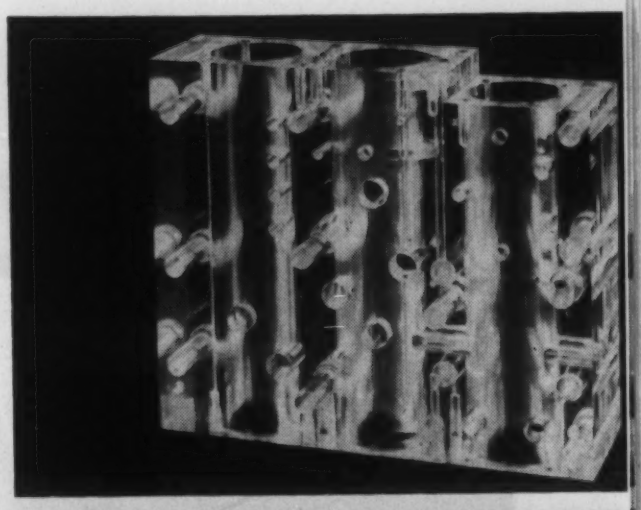
Older, basic materials in new applications . . .

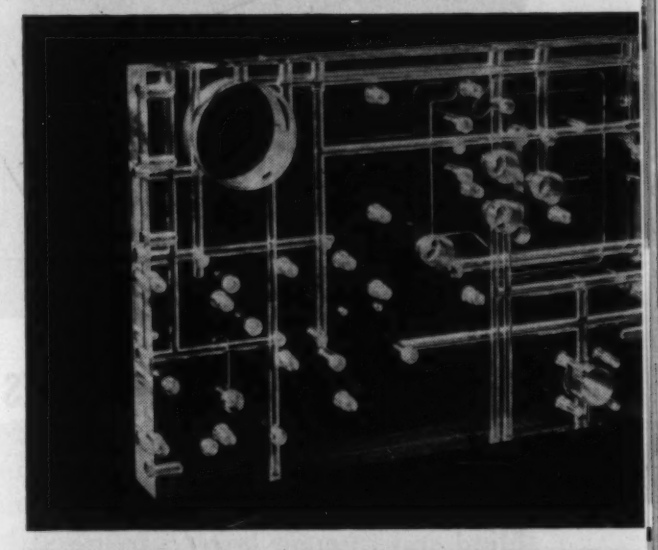


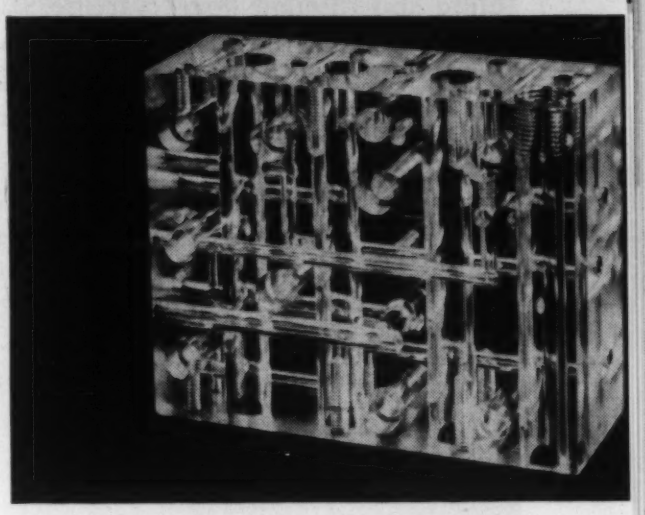
DIE CASTINGS AND PLASTIC MOLDINGS IN FIELD GLASSES Zinc die castings and molded plastics are frequently complementary rather than competitive. The Super-Sight field glass is a good case in point. All of the components of this low cost product, except the lenses and screws, are die cast or injection molded.

The dual housing is a one-piece zinc die casting. To minimize both the weight and the amount of metal consumed, the housing is cast in thin section, as indicated by the cross members. This casting is attractively and inexpensively finished in a black crinkle baked enamel. Two other parts in the photo are injection molded at low cost, with no further operations required to endow them with a high gloss which contrasts with the crinkle effect on the die casting housing. The treaded focusing screw is molded in place in the larger plastic part. (Courtesy New Jersey Zinc Co.)





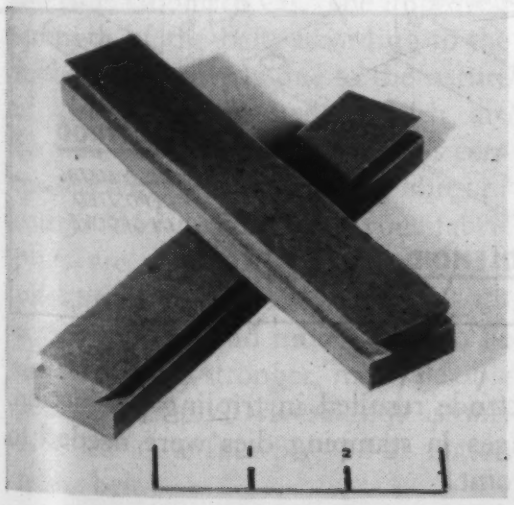




ACRYLIC INSPECTION MODELS AND TEMPLETS The Norton Co. gets into very complicated drilling work in making hydraulic parts for their grinders. One manifold panel requires 167 holes—the largest 7/8 in., the smallest 1/4 in., and the longest 31 in.

For work like this, they have found it very helpful to prepare models made of transparent acrylic. These show all holes, their distances from each other, and the location of the ends. The plastic models tell the story quicker and easier to the operator and the inspector than the several sets of blue prints that would otherwise be required. When the inspector checks the completed job, he uses a plastic model and a set of rods on which the length of the hole is marked. Thin templates of acrylic are also used for inspectors to check size and position of holes.

These models are prepared in the drilling department very inexpensively when the first lot of parts are produced. After careful inspection they become inspection and engineering references for all future lots. In a few cases they have indicated desirable design changes before assembly of the first mechanism.



LAMINATED PLASTIC VIBRATOR BLOCK A new vibrator block for Draper textile looms is made of Synthane Corp.'s L-RF laminate with filler of the non-woven random cotton fiber mat known as Lantuck, recently developed by Wellington Sears Co. and West Point Manufacturing Co. Synthane claims that Draper loom users can expect to get 60 times longer life out of laminated plastic vibrator blocks than they normally get from wood vibrator blocks, at only 6 to 8 times the cost. The new blocks are claimed to eliminate the damage which wooden blocks often do to other parts of the looms—especially to whiproll cams and followers. They also reduce production losses that occur when looms are stopped for repairs or replacement of parts.

Materials at Work

PHENOLIC CIRCUIT BREAKER CASES Large intricate molded phenolic cases and covers for the I-T-E Circuit Breaker Co. units are made quickly and at a comparatively low cost in Durez phenolic. In the interiors of these parts, blind and through holes, varying wall sections and inserts are molded by American Insulator Co.

The larger part is used on metal-back circuit breakers known as the type KC. This breaker has a continuous current rating up to 1600 amp, a voltage rating of 600-v a.c., 250-v d.c., and an interrupting rating of 50,000 amp. The two smaller parts are the base and cover for a two-pole, 100-amp, F-frame type, ET circuit breaker. This particular breaker is furnished in ampere ratings up to and including 100 amp, voltage ratings of 200-v d.c., 600-v a.c. maximum, and an interrupting rating of 15,000 amp.

VINYL PLASTIC CASE New models of the Synctron Electronic Flash offer easier portability and greater strength and safety. A high impact, low pressure formable vinyl sheet material, Boltaron, is molded to make a case that is light in weight, yet highly resistant to scratching or chipping even during the roughest use. Manufactured by Dormitzer Electric and Manufacturing Co., Inc., the unit consists of a portable power pack and lamp head. Designed for taking flash pictures, this equipment requires a high electrical voltage to be stored in the power pack. The insulating qualities of the Boltaron plastic case help to give the photographer protection in all kinds of weather. Exposure to rain or snow does not harm the case as the Boltaron material is waterproof, mildewproof and stainproof. It wipes clean with a damp cloth.

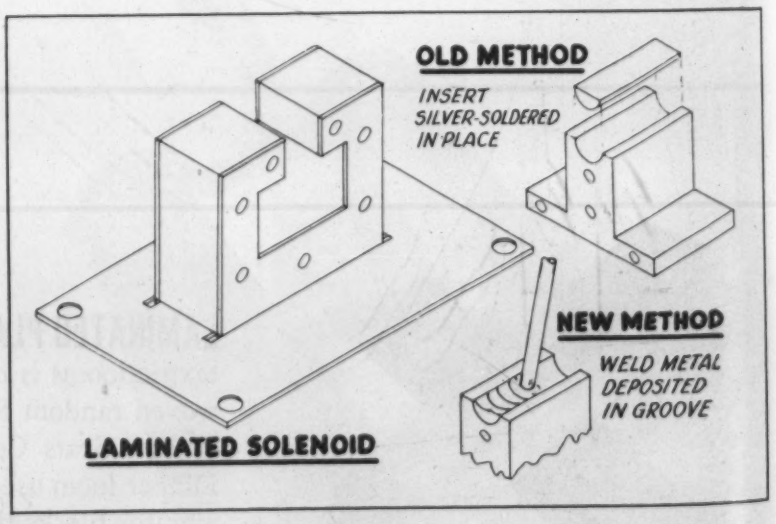
Ribbing on the bottom of the case transmits strains and stresses, assisting the material to stand up rigidly under the load. A stainless steel strip adds further vertical rigidity and serves to cover the joining edge. Where the lamp head flows from round to rectangular, the ribbing adds strength and streamlined appearance.

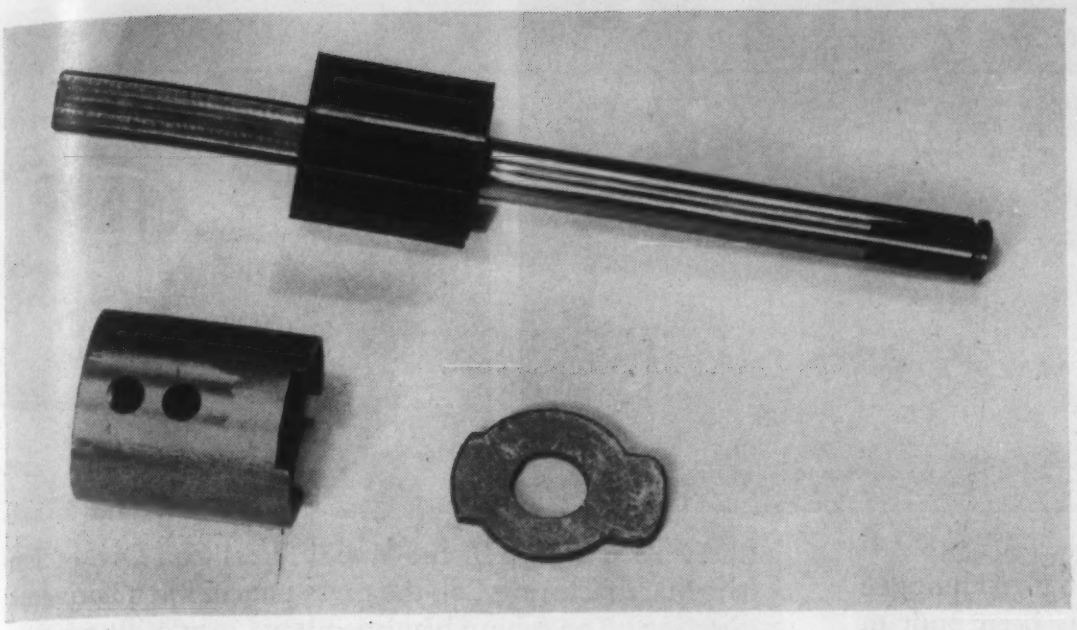
HARDFACED SOLENOID ANVILS A change from silver soldering to arc welding netted a 37% saving in material cost and a tenfold increase in out-put of hard surfaced solenoid anvils.

These solenoids operate control mechanisms. The anvil, or point of contact on the core, must have Rockwell C hardness of 55-60 for optimum wearing qualities. Former practice was to silver solder a hardened steel insert into a machined groove in the anvil face. Production was about 100 anvils per operator per day.

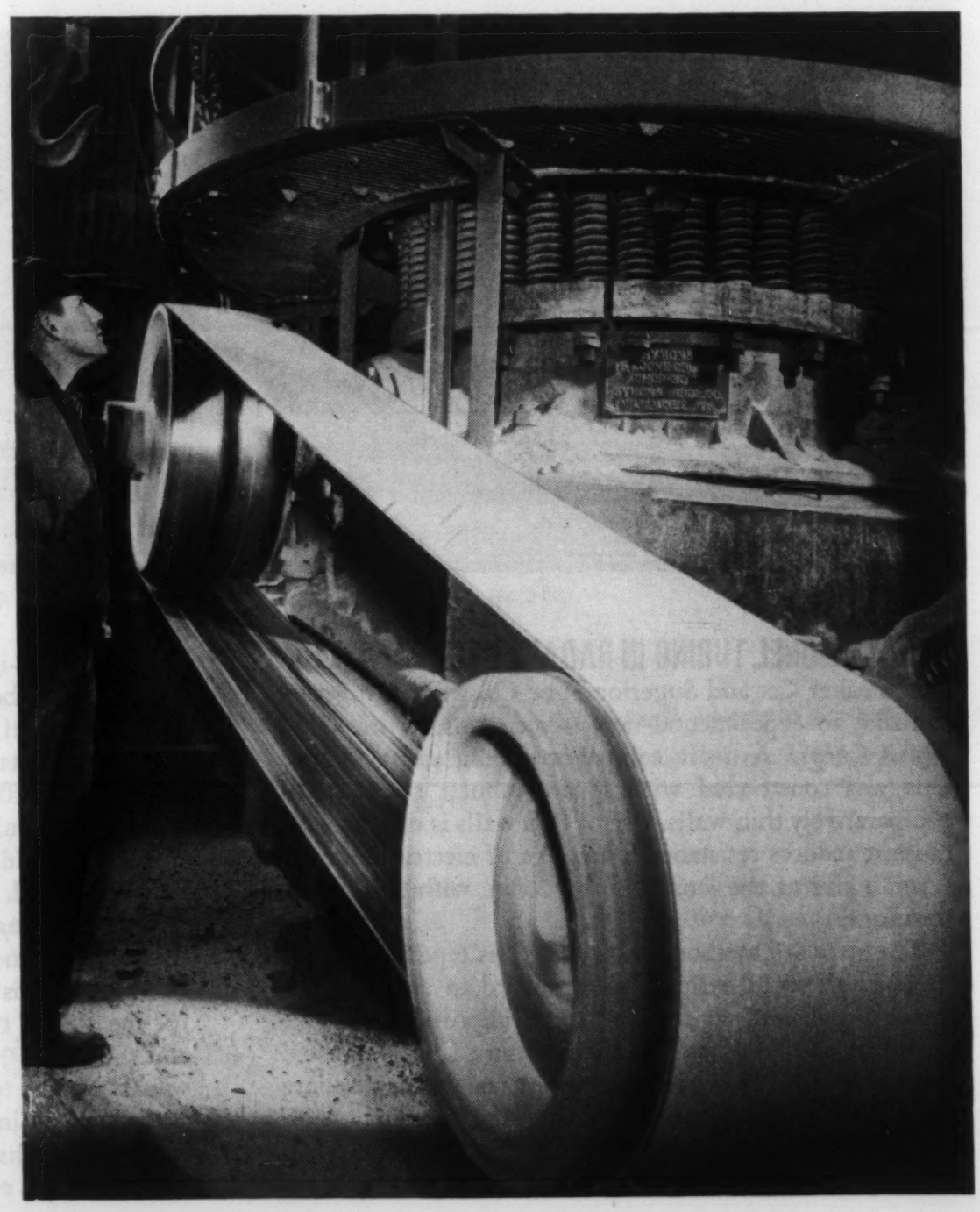
Now, anvils are clamped end to end in a fixture and 5% chromium tool steel is laid in the groove in one pass, using Lincoln Electric Co.'s Toolweld A & O (air and oil hardening) shielded arc electrode. An average of 55 pieces can be faced with 1 lb of electrode. A single operator can turn out 1000 anvils per day.

The solenoids are attached to 12- to 14-gage steel bases. A change from silver soldering to a single pass with a mild steel arc welding electrode resulted in tripling production. Only two slight changes in stamping dies were needed to facilitate the welded joint.



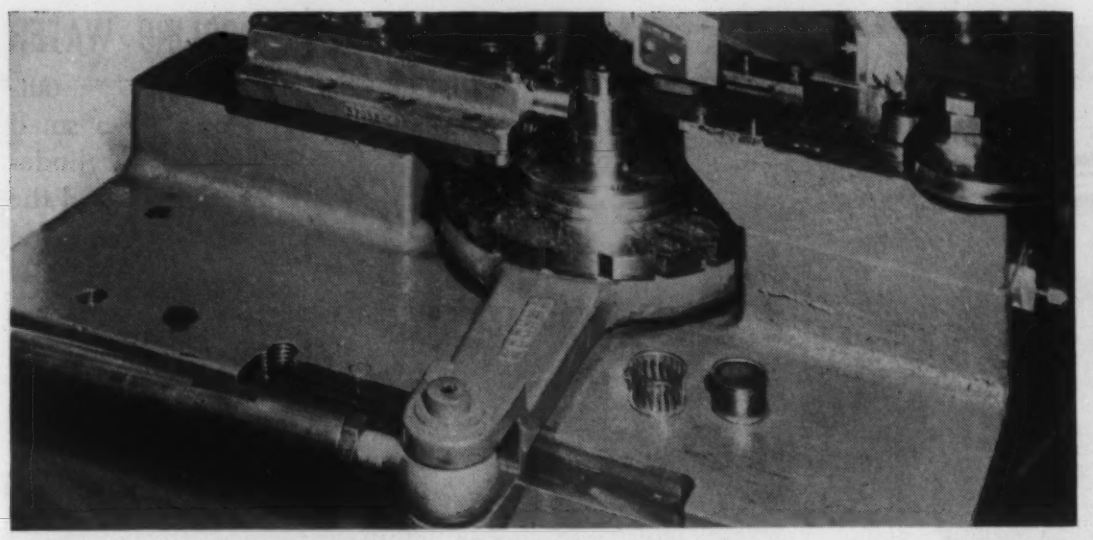


MATERIALS IN COOLING WATER PUMP Cooling water for an outboard motor is pumped by a small unit of unusual design. The cylinder that serves as the pump body and the single plate that is the cover are made of sintered bronze powder. No machining is required. The pieces are made by United States Graphite Co. A molded rubber paddle is mounted on a stainless steel shaft to form the impeller. This simple unit is used by West Bend Aluminum Co. in its marine motor.

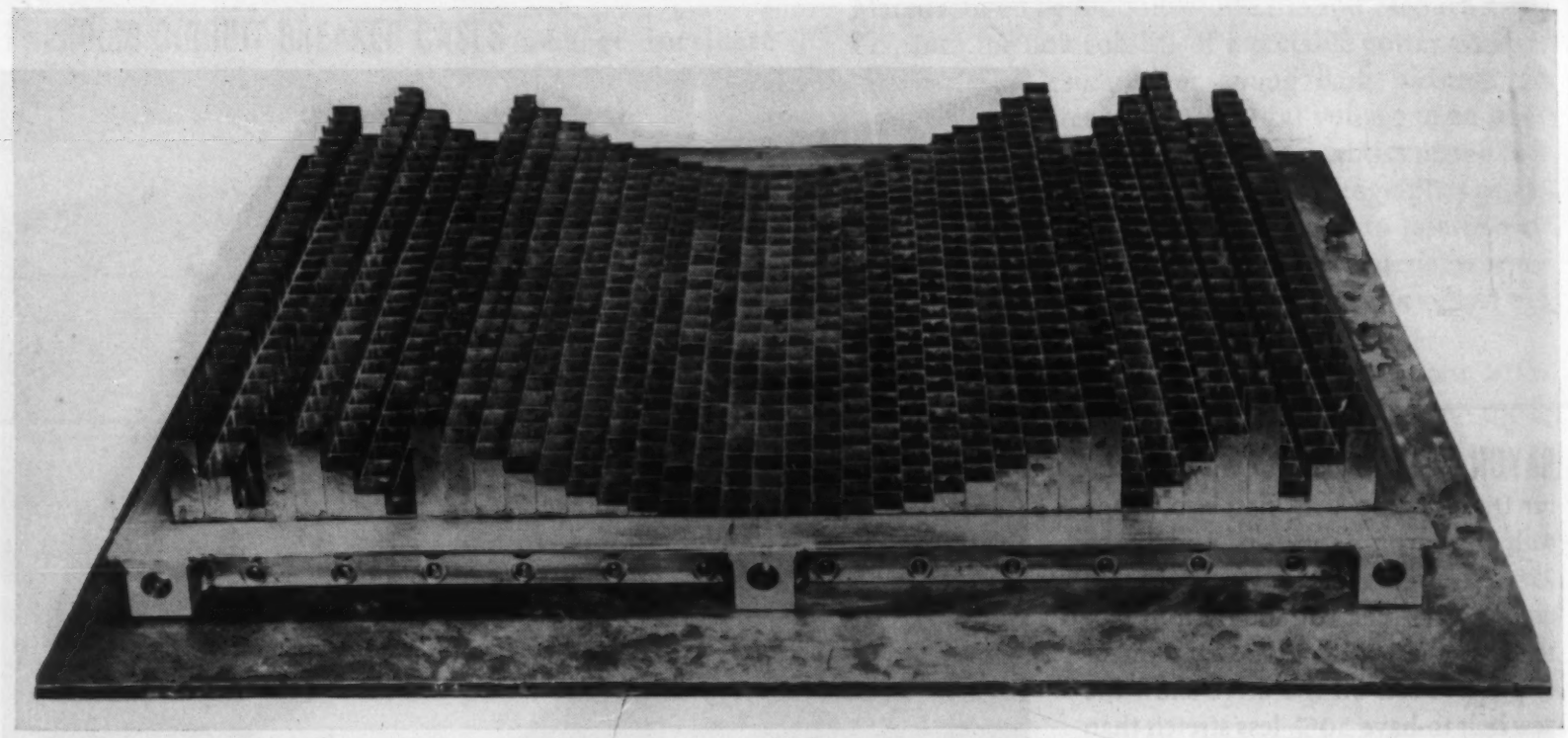


RAYON FABRIC BELT A new rubber transmission belt, first ever made with all rayon fabric, is said to be 25% stronger and have up to ten times greater flex life than cotton fabric belts made with the same number of plies. Tests on the drive show the new belt to have 50% less stretch than cotton fabric belts.

Called Drivesall, the rayon fabric belt is the result of five years of laboratory tests and field development by the B. F. Goodrich Co. The improved strength of the belt, according to the rubber company, is due to the nature of the rayon filaments which are formed in continuous lengths, as contrasted with the short length fibres of cotton duck. Because rayon fabric plies are 30% thinner than cotton plies, they flex easier over small diameter pulleys and more plies can be used to make stronger, more flexible belts. A six-ply Drivesall belt is only as thick as a four-ply, 32-oz cotton fabric belt.



PRESS-PIERCED NEEDLE BEARING CAGE Equipped with a special fixture, a power press has been built to pierce the cage of needle bearings. This new cage replaces a cast product. Operating at a speed of 100 strokes per min, the machine pierces 19 rectangular shaped holes, 7/64 in. wide by 5/8 in. long, in bronze tubing 0.025 in. thick. As designed by the V & O Press Co., Div. of Emhart Manufacturing Co., the press punches in a horizontal direction. The tubing blank is placed over a die where it is automatically pierced and indexed for the successive slots. When the required 19 piercings are completed, the machine stops automatically. An 18-ton press was adapted for the application.

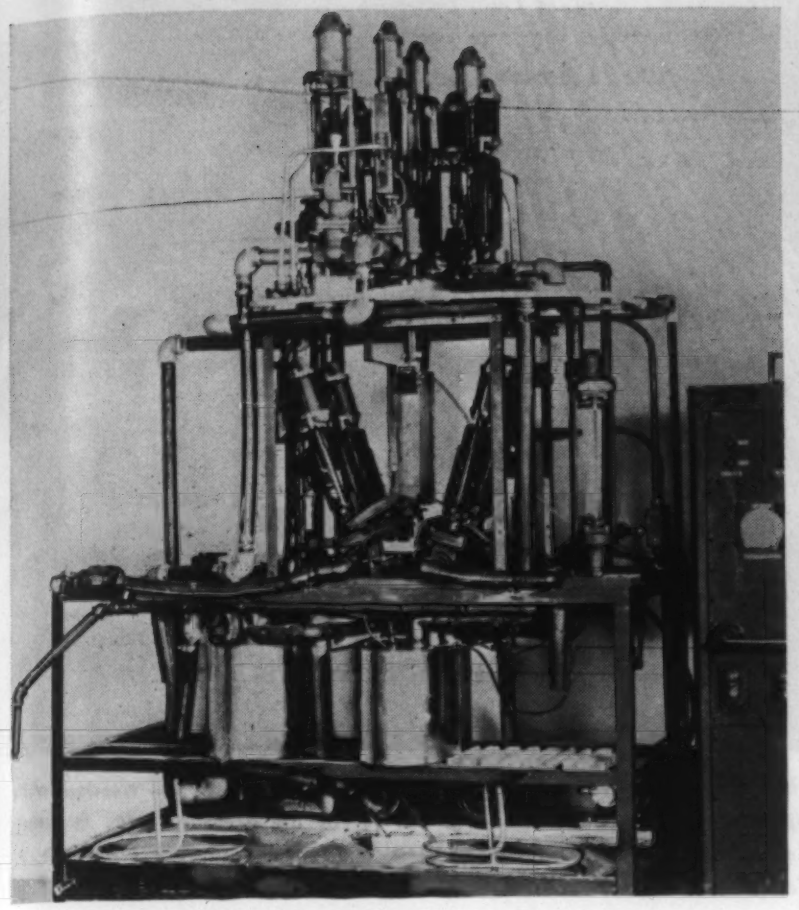


SQUARE MONEL TUBING IN RADAR SCREEN I-T-E Circuit Breaker Co. and Superior Tube Co. worked together to make an experimental radar screen lens for the U. S. Signal Corps. A small, compact parabolic radar antenna lens was constructed with square tubular openings of comparatively thin walls. Use of thin walls is desirable because it reduces resistance to passage of electrical energy. Overall size of the lens is 30 by 20 in. with 988 square openings.

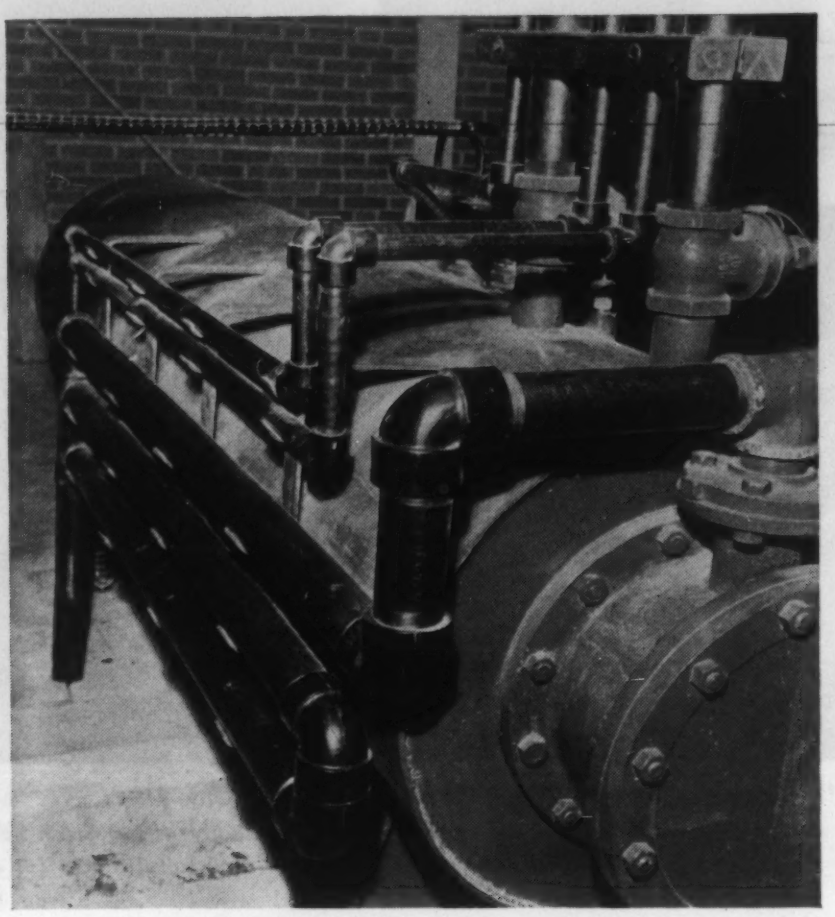
The standard method for making this type of lens was to assemble metal strips like cardboard in an egg-crate, then solder tight. It was felt to be impossible to make openings absolutely square, maintaining thin walls and sharp corners. I-T-E tried assembling square brass tubing cut to exact lengths and furnace brazing in a jig. With the softest available silver solder, the tubing failed to braze properly and serious cracks developed at sharp corners (1/64-in. radius inside).

Superior Tube Co. engineers recommended hard-drawn seamless monel tubing to provide the desired strength, corrosion resistance, electrical properties and ease of brazing. About 2000 pieces of tubing were cut to exact lengths, flash nickel plated, tin plated, and coated with soft silver solder, assembled in an adjustable jig and then furnace brazed.

Cross-sectional dimensions of each piece had to be held to close tolerances to keep the tolerance on the overall size of the lens within reasonable limits. Specifications for the square tubing called for 0.750- to 0.005-in. i.d., and 0.007- to 0.001-in. wall. Total allowable convexity was 0.010 in.; total concavity, 0.000 in.; radius on inside corners, 1/64 in. max. Parts were to be furnished in 20 different lengths, from 1.500 to 4.527 in., with tolerance of 0.010 in. on each length.



FLEXIBLE POLYETHYLENE PIPE is used in Raytheon Manufacturing Co.'s high-speed film strip processing unit. It resists corrosion by solutions, is easy to cut and install, and is lower in cost than stainless steel. (Carlon Products Corp.)



SARAN PIPE and fittings in typical industrial installation. Corrosion resistance and ease of installation are valuable characteristics. (Dow Chemical Co.)

Seven Kinds of Plastic Pipe . . .

Their Properties and Uses

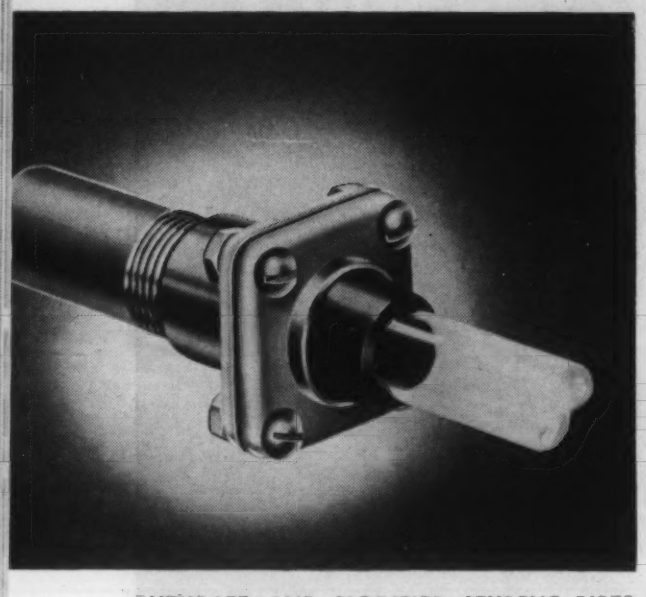
by **PHILIP O'KEEFE,** Associate Editor, Materials & Methods

As a family, plastics pipe features good corrosion resistance and light weight . . . Sizes ranging from 1/2 to 6 in. in dia are available.

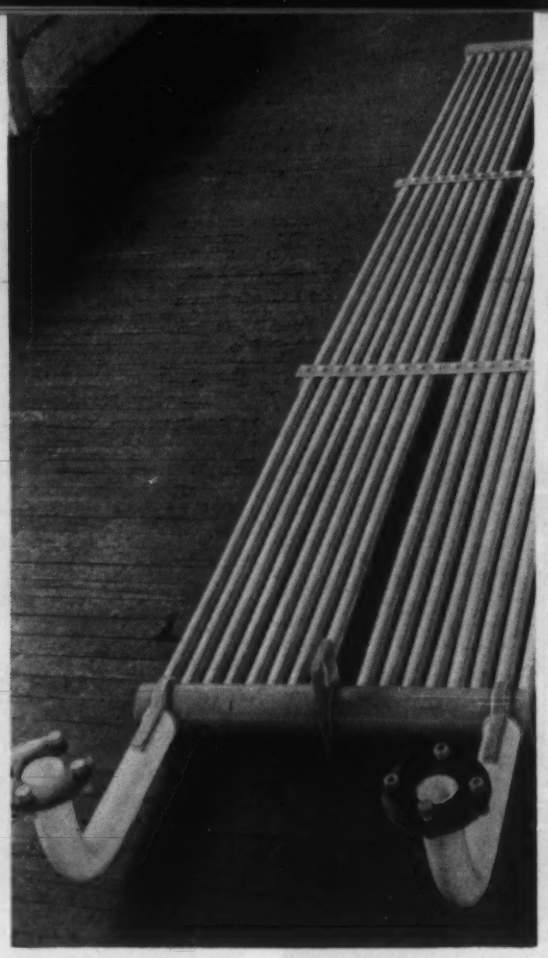
● PLASTICS PIPE has been used for some time for handling cold water from the curb to the house, in irrigation systems, to water farm stock, for natural gas, and more recently, in the transmission of chemicals, crude oil and gases. Many other industrial applications are now being studied.

While the properties and available sizes of plastics pipe vary with the material, some general advantages are characteristic of the whole family. They are usually more resistant to corrosion than iron, steel, copper and brass pipe. They are lighter in weight for a given capacity. While the working pressures for plastics are comparatively low and the allowable temperatures are restricted, a plastics pipe invariably carries more fluid than a metal pipe of equal size because of its smoother, less retardant surface. Some plastics pipe is flexible, which makes installation easy. The solvent-welded joints and clamp joints used with pipe of some materials also simplify installation.

Plastics pipe is still growing. Much research and development still needs to be done before large scale industrial applications are possible. New materials are being developed. More complete lines of fittings will certainly have to be developed for the average industrial installation. Most of the pipe so far has been thermoplastic; thermosetting pipe should come into increasing importance for higher pressures and temperatures.



BUTYRATE AND MODIFIED STYRENE PIPES use solvent welded slip fitting joints. Adaptor plates make joints with metal pipe. (Elmer E. Mills Plastics, Inc.)



RIGID VINYL PIPE is being used more extensively in industrial setups. This installation handles sulfuric acid for a glass concern. (Van Dorn Iron Works Co.)

RIGID VINYL PIPE can be welded with a hot jet of air or other gas. Welding rod is also made of rigid vinyl. (B. F. Goodrich Chemical Co.)

As yet there are no industry-wide standards devoted specifically to plastics pipe. Although sizes, wall thicknesses, material composition and even joining methods may vary between manufacturers, standard metal pipe sizes are generally used.

Polyethylene

A flexible thermoplastic, polyethylene is one of the lightest of the plastics. It is by far the most popular pipe plastics material, accounting for over half of the plastic pipe made. Specific gravity is 0.92. Tensile strength for pipe grades is given as 1800 to 2000 psi. Impact strength is good, even at low temperatures, but resistance to sunlight is not outstanding. With no load, continuous temperatures up to 212 F can be withstood, but the low-load distortion temperature is given as 105 to 110 F. Water absorption is negligible. Polyethylene ignites and burns slowly. The material is resistant to acids and alkalies, although it is attacked by organic solvents at elevated temperatures. Its machinability is not particularly good.

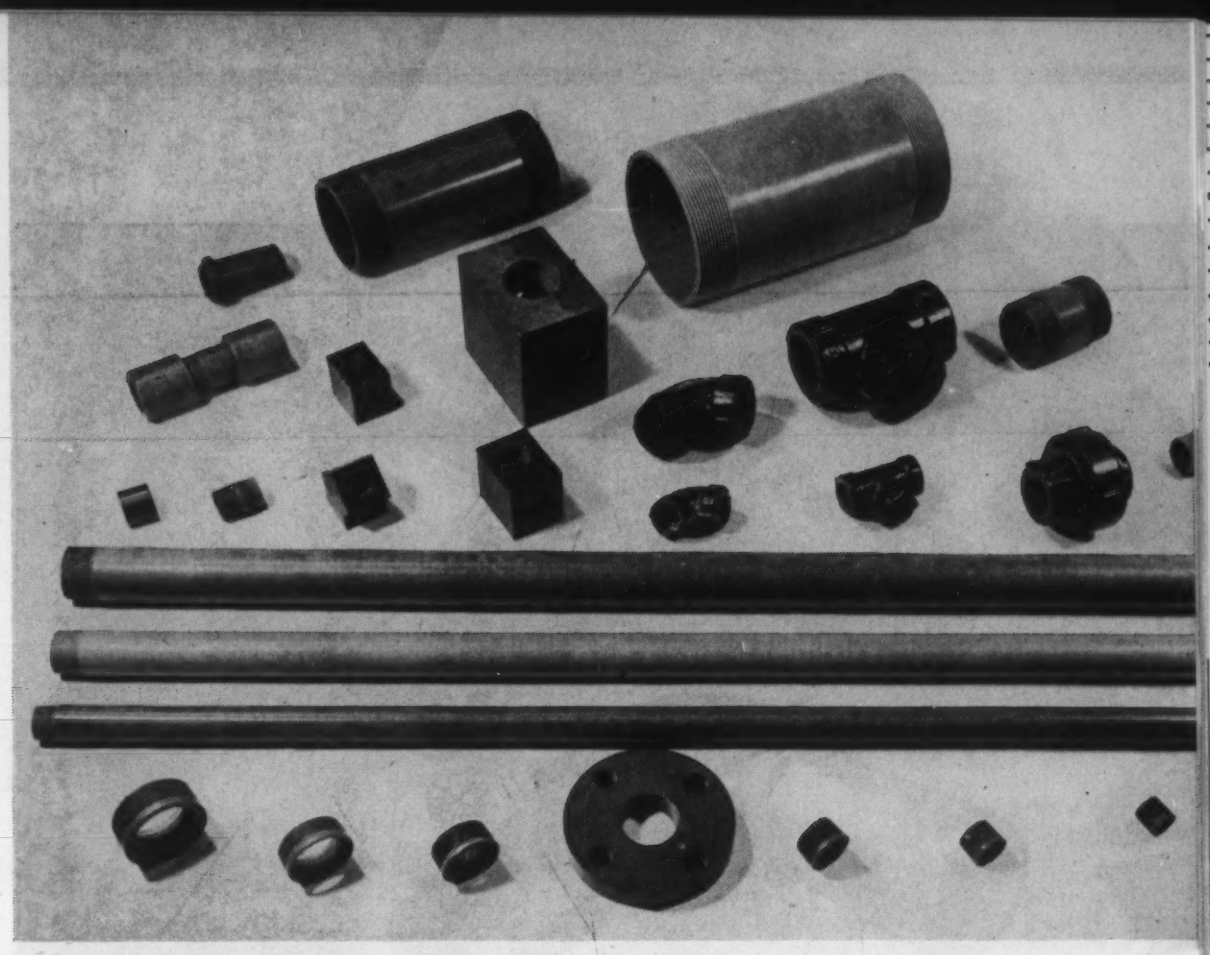
Polyethylene pipe is made in from ½- to 6-in. sizes. The dimensions are roughly similar to those of corresponding sizes of standard and extra heavy iron pipe. At 120 F, 6-in. pipe with extra heavy wall thickness has a working pressure of 75 psi. At the same temperature, 1-in. pipe is designed for 120 psi. Polyethylene pipe is joined by insert couplings and stainless steel clamps. These fittings can be made of brass or polystyrene. Adapter fittings are used to connect standard pipe threaded fittings. This pipe comes in coiled sections up to 400 ft long.

Light weight, flexibility, high impact strength, and above all, chemical inertness, are the selling points of this pipe. Beer and beverages, fumes, photographic solutions and paper mill solutions are among the fluids carried successfully. A big advantage to polyethylene pipe is that it is flexible enough to be looped and curved around obstacles. This is valuable in plant and house cold water systems, mine drainage systems, radiant heat setups, sewage disposal and irrigation. This pipe can also be used at very low temperatures, without embrittlement troubles. Water, for example, can freeze in this pipe without damaging it. At the other end of the temperature scale, polyethylene pipe is kept at 110 F in radiant heating installations without trouble.

Modified Polystyrene

Modified polystyrene forms a rigid pipe with greater bursting strength than polyethylene. It has a specific gravity of 1.054 to 1.070. Modified polystyrene ranges in impact strength from 3 to 40 times that of polystyrene, depending on the type and grade. The highest impact types can be pounded flat or hit with a bullet without rupturing. The material can be transparent or opaque, and color possibilities are unlimited. It burns at a moderate rate and is resistant to continous exposure at 150 to 170 F without distortion. Tensile strengths are given as 5000 to 9000 psi. Water absorption is negligible, and the effects of sunlight and aging are slight. Polystyrene is not attacked by acids or alkalies, although strong acids may discolor the material. It is soluble in

GLASS-REINFORCED POLYESTER *is light and strong. It is being used in oil field applications. (United States Plywood Corp.)*



THERMOSETTING HIGH PRESSURE LAMINATES are made as standard pipe and fittings. Insulating bushings are one application. (Synthane Corp.)

aromatic and chlorinated hydrocarbons.

Most of the pipe is made from high-impact rubber-modified polystyrene and styrene copolymers. This pipe is extruded in three wall thicknesses from ½- to 6-in. sizes. The outside diameters correspond to standard and extra heavy metal pipe, with a third grade somewhat lighter than standard. Solvent welded slip joints, similar to those used with butyrate, are recommended. The pipe can be threaded, but this is not good practice. Threaded fittings are injection molded for metal-to-plastics connection, however. Working pressures for light pipe at 75 F are 110 psi for ½ in. and 30 psi for 40 in. Extra heavy pipe at the same temperature takes 200 psi in ½-in. and 80 psi in 4-in. sizes.

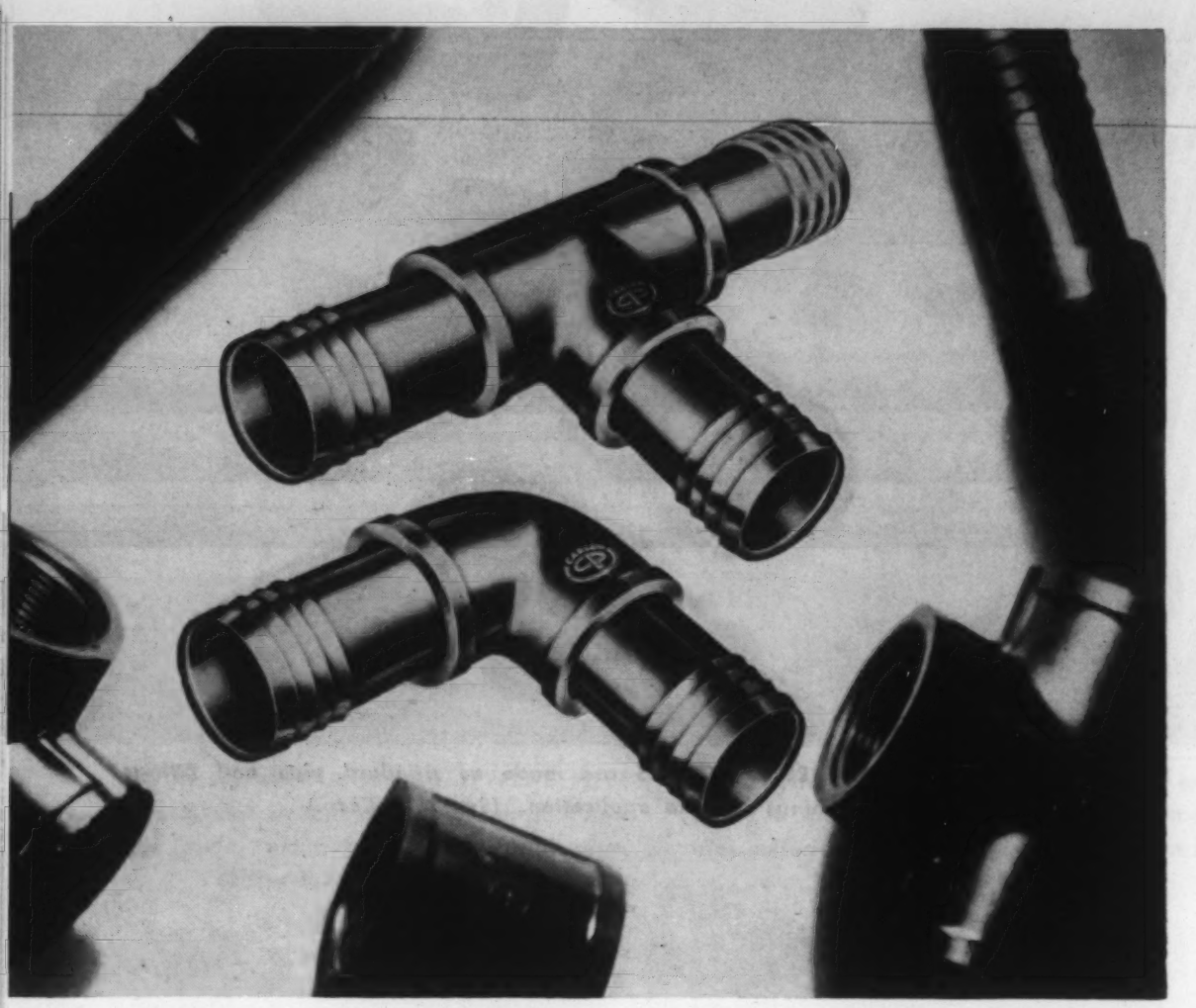
Modified polystyrene pipe is easy to install, nontoxic and corrosion resistant. It is used in rural water systems, irrigation, mine water disposal, well casings, chemical drain lines, sprinkling systems, for electrical conduit and for transmission of sewage. In general, the applications are similar to those of butyrate. Although some of the modified polystyrenes are not acceptable for petroleum products, types modified with acrylonitrile are generally satisfactory.

Butyrate

Cellulose acetate butyrate competes with modified polystyrene for the semi-rigid to rigid pipe market. It has a specific gravity of 1.14 to 1.22. Its tensile strength is 2500 to 7500 psi. The softening point is between 140 and 250 F. The material burns, but slowly. The impact resistance is greater than that of Saran, and the 24-hr water absorption is higher, 1.2 to 2.0%. Aging has a slight hardening effect. There is no attack from weak acids, but the material decomposes with strong acids. Weak alkalies have no effect, while strong alkalies attack butyrate. The material is soluble in ketones and esters, is softened by alcohol, but is little affected by hydrocarbons.

Butyrate pipe is extruded in sizes from ½ to 6 in. Wall thicknesses vary with the application. Butyrate is often used in transparent form. The working pressures depend on temperatures. With ½-in. pipe, 199 psi is allowed at 60 F and 29 psi at 180 F. Butyrate is joined by solvent-welded slip-sleeve couplings, or flange union adapters. Standard couplings are injection molded. The pipe is not designed for threading. The sizes are purposely made different enough from standard metal pipe sizes so that they cannot be threaded on standard pipe dies.

Much butyrate pipe finds its application in oil fields. It is used to carry salt water, crude oil and natural gas. Burial of this pipe is recommended for protection against weathering and other hazards. A main advantage is its ability to withstand salt water and corrosive earth attack. There is no electrolytic action with butyrate pipe. With metal and cement pipe, paraffin falls out of solution in oil lines, causing clogging in a short time. This paraffin does not clog butyrate pipe, which can be kept in service without shutdowns to scrape the paraffin out. This pipe is also used for home gas and cold water lines. It is being tested for plant installations carrying brine cellulose acetate slurry and acetic acid with traces of sulfuric acid. Transpar-



Insert type fittings are used with flexible polyethylene pipe. A metal ring clamp on the outside of the pipe holds the joint tight. (Carlon Products Corp.)

ent butyrate pipe is advantageous in industrial plants because it allows flow to be seen.

Saran

Saran is the trade name for a series of thermoplastic vinylidene chloride polymers and copolymers. The specific gravity is 1.6 to 1.75 and the tensile strength ranges from 3000 to 6000 psi. The 24-hr immersion water absorption is 0.00 and the plastic is resistant to a continuous temperature of 170 F. Saran becomes stronger with age and does not burn. It is an excellent heat insulator and a good electrical insulator. Acids and alkalies have no effect, and the material is highly resistant to organic solvents. Sunlight has a slight effect on Saran, and it becomes brittle at low temperatures. It has excellent machining qualities and can be heat-welded with a hot air gun. It is made in any color, translucent or opaque.

Saran pipe is extruded in ½- to 6-in. nominal sizes. The dimensions are similar to those of extra heavy iron pipe. Working pressures vary from 260 psi for ½-in. pipe to 80 psi for 6-in. Most applications are at room temperature but Saran can be used with slightly warmer fluids. Standard molded fittings are available and fabricated fittings can be made by welding. Saran valves are also available. The pipe can be threaded with slightly modified dies. Lengths can also be joined by welding.

The big advantages of Saran pipe are chemical resistance and light weight. Saran pipe weighs only ¼ as much as iron pipe of comparable size. It is more expensive and heavier than the three plastics materials mentioned above. Saran has replaced aluminum, stainless steel, nickel, copper, brass, tin and rubber in many applications. It is used to carry carbon dioxide, compressed air, refrigerants, hypochlorite solutions, hydrofluoric acid, and electroplating solutions, among other things.

Rigid Vinyl

Polyvinyl chloride is a strong, tough plastic with excellent acid, alkali, solvent and light resistance and good electrical properties. Tensile strength is 7000 psi, flexural strength is 14,000 psi, and the specific gravity is 1.35 to 1.45. Sulfuric acid, hydrochloric acid, nitric acid, sodium hydroxide, saturated salt solutions, organic acids, alcohols and organic solvents can be handled with rigid vinyl. It can be fabricated by welding techniques. The top service temperature is given variously as 160 to 170 F, and properties are not changed down to −70 F. The material can be machined and pipe can be threaded with regular pipe dies. Pipe can also be hot formed at 250 F.

Rigid vinyl pipe is being extruded in this country in ½- to 4-in. standard pipe sizes. The bursting pressure for 1½-in. pipe has been found to be 2000 psi. In Italy, pipe up to 15 in. in dia, with ½-in. walls is being made. Standard threaded fittings are transfer molded and also injection molded using the preplasticizer principle. Larger fittings can be fabricated by welding.

The big selling point of rigid vinyl is corrosion resistance. It is also strong enough to support its own weight and can be used in industrial piping installations in much the same way as metal pipe. Although vinyl pipe was used extensively in Germany during World War II, it is relatively new in America. Applications are envisioned in chemical piping, heat exchangers, irrigation systems, process lines and equipment fabrication (along with sheet and other extruded shapes). Vinyl pipe is stronger than the other thermoplastic pipes and can be used at higher pressures.

Polyester

Glass reinforced polyester pipe material has a tensile strength of about 40,000 psi. Flexural strength is 48,000 to 55,000 psi, and specific gravity is 1.8. With proper techniques, the material can be machined

Prices (1951) of 2-In. Pipe Made of Different Commercial Materials

Material	Price ¢/Ft	Weight Lb/Ft
Stainless steel	432	(3.65)
Brass	225	4.12
Rigid vinyl	165	1.38
Flexible vinyl chloride plastic	120	1.09
Cellulose acetate-butyrate	70	0.45
Polyethylene	66	0.44
Modified polystyrene	62	0.45
Galvanized iron	40	3.66
Black iron	29	3.66

(Paley Report)

and threaded. Solvent cements have been developed. The chemical resistance of glass reinforced polyester is high, but the outstanding properties are strength and resistance to continuous temperatures up to 275 F.

Polyester pipe is made in diameters up to 12 in. Wall thicknesses vary with the size. The bursting pressure for 1-in. inside dia pipe with a wall thickness of 0.080 in. varies from 3000 to 7350 psi, depending on how the pipe was made. Bursting pressures of 5-in. inside dia pipe with 0.310-in. wall thicknesses are 2850 to 5700 psi. Joints are made with threaded fittings of the same material, or with plastic flanges bonded together at installation.

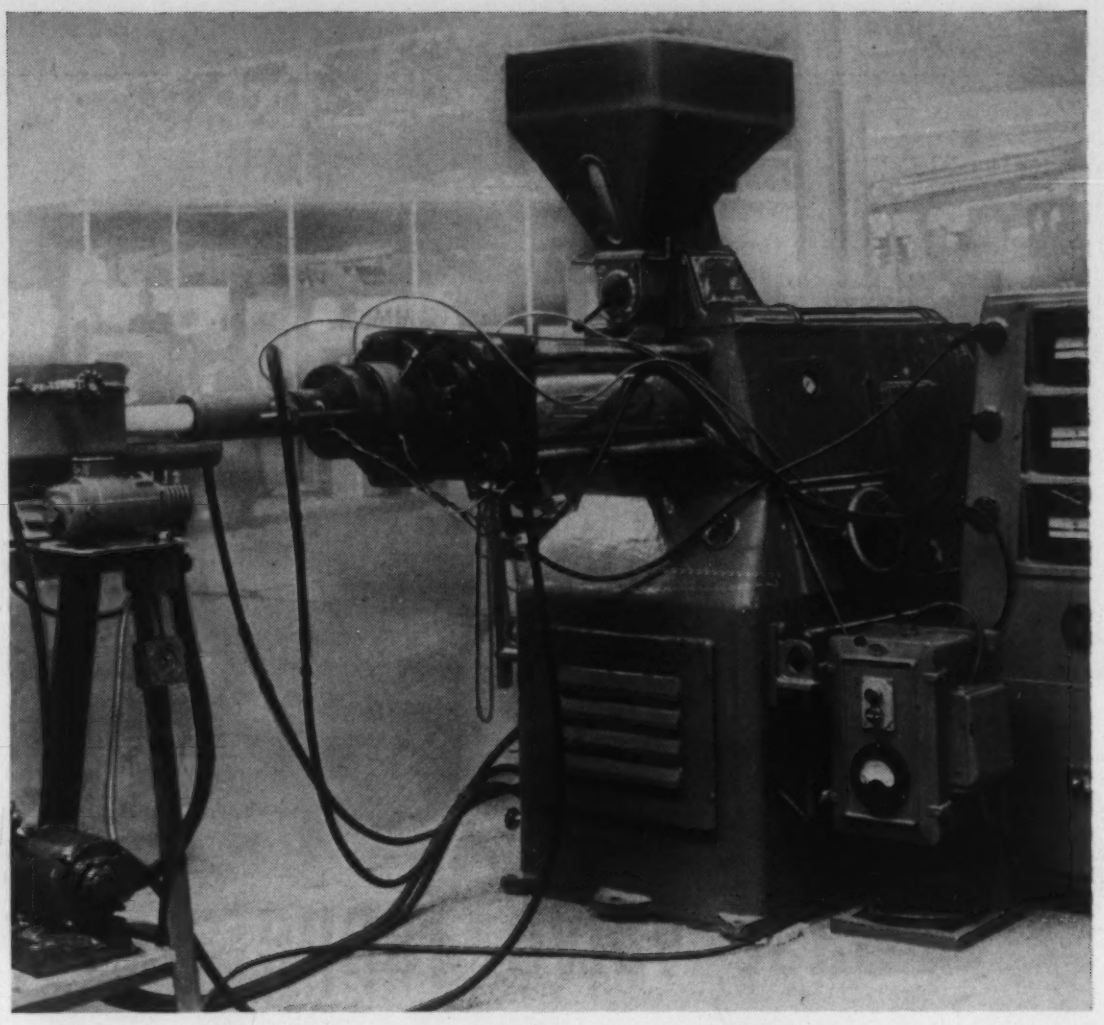
Due to manufacturing problems, fittings cannot be made as strong as the pipe itself. In piping applications using fittings, a working pressure of 600 psi is recommended. For straight line pipe, using just couplings and pipe, the working pressure is determined by multiplying the bursting pressure by an appropriate safety factor. For the most part, there are no standard pipe sizes. The wall thicknesses are engineered to fit the application.

Glass reinforced polyester pipe is used where resistance to weathering, salt or fresh water is required. It is resistant to sulfuric, hydrochloric, nitric, acetic and other acids, as well as to aromatic and aliphatic hydrocarbons such as gasoline, oil and other fuels. Polyester pipe is stronger than any of the other plastic pipes. It resists erosion at turns particularly well with fast moving liquids. This pipe has been tested by the Navy and is to be used on minesweepers where nonmagnetic materials are desirable. It is also being used in oil fields—not as ground pipe, but where structural strength is needed.

While polyester pipe has the lightness and corrosion resistance of plastic pipe, as well as strength associated with metal pipe, it is still under development. Several manufacturing processes are used. A new technique is to use glass yarn instead of fabric. This cuts down the air inclusions and is designed to improve the physical properties. Some thought is also being given to developing an impregnating resin superior to polyester.

Thermosetting Laminates

Some pipe is also made from cotton, nylon, asbestos and glass filled phenolics and melamines. Physical characteristics vary between grades.



Thermoplastic pipe is made by extrusion. Pipe is shown leaving the forming box and entering the cooling box. (F. J. Stokes Machine Co.)

Specific gravity ranges 1.15 to 1.80, and tensile strengths from 6000 to 30,000 psi, depending on the filler used. Impact strength is good, even at low temperatures. These laminates machine very well. They can be exposed to continuous temperatures up to 225 to 300 F. Cotton fillers are satisfactory for handling weak acids, most salt solutions and organic solvents. Asbestos fillers are resistant to alkaline solutions but are not recommended for acids. Glass fabric is best for strong acids or acid salt concentrations.

Molded filled phenolic and melamine pipe is available in sizes up to 6 in. with standard, heavy and extra-heavy wall thicknesses. Standard pipe lengths are 36 in., with some grades supplied in lengths up to 48 or even 96 in. Standard couplings, plugs, reducing bushings, caps, elbows, tees and crosses are available. Threaded connections are made, of course. Working pressures vary from 1250 psi for 1.8-in. standard and 2275 psi for 1.8-in. extra-heavy down to 225 psi for 6-in. extra-heavy.

Thermosetting laminate pipes of this kind are used in the oil industry. Insulating bushings made of cotton fabric-phenolic are used to insulate metallic pipe lines against electrolysis. In the textile industry, nylon sizing machines use laminated pipe for polyvinyl alcohol sizing. Air agitator spiders withstand chromium plate solution. These materials are also used to carry various bleaches and dyes.

Acknowledgments

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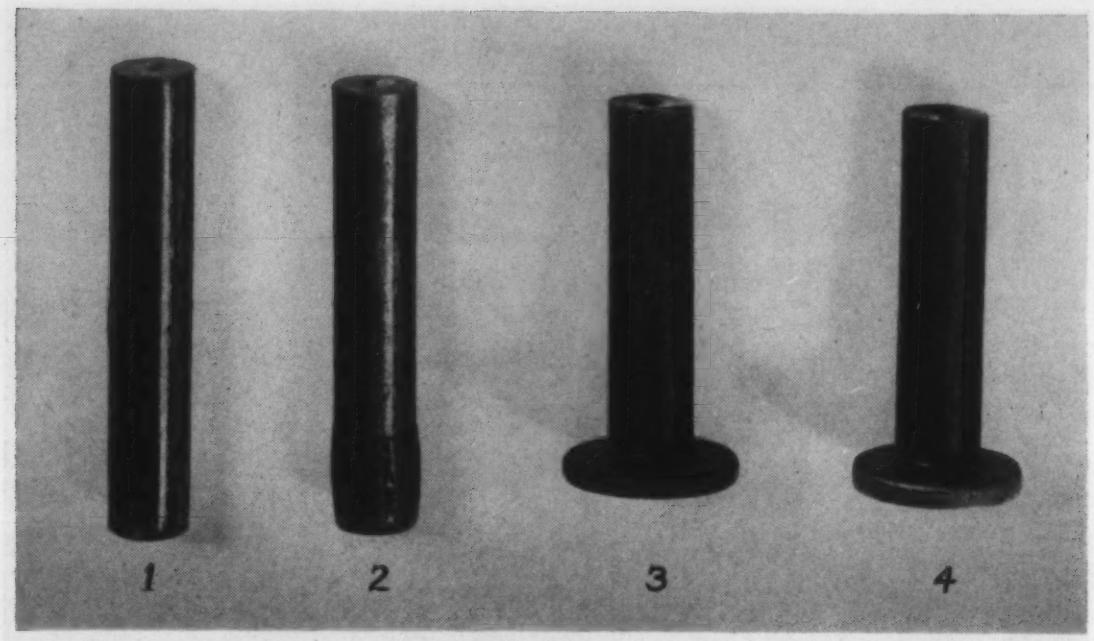
F. J. Stokes Machine Co.
Synthane Corp.
Tennessee Eastman Co.
United States Plywood Corp.
United States Rubber Co.
Van Dorn Iron Works Co.
Yardley Plastics Co.



Steps in production of formed steel tappet: (1) Blank cut from wire. (2) After first heading and ball recessing. (3) After final heading and ball recessing. (4) Finished headed part after head is trimmed, but before groove is rolled on stem next to head.

Cast Valve Tappets Redesigned for Formed Steel

Steel is carbonitrided after cold forming to provide a satisfactory part.

by Kenneth Rose, Mid-Western Editor, Materials & Methods

● VALVE TAPPETS for automotive engines are usually made as gray iron castings and machined to finish dimensions. Adoption of overhead valves for the six-cylinder engine for Ford Motor Co.'s passenger car line made necessary the use of valve tappets in this engine, and the company's engineers studied the possibility of cold-forming the tappets of steel. This had not been done heretofore in the automotive industry.

After experimenting with boron steels, SAE 5135 steel, and several other types, it was decided to use SAE 5120 steel and carbonitride after forming.

The material used is ½-in. coiled cold drawn wire, type 5120 steel, having a fine grain double extrusion finish. Actual size of the wire is 0.499-in. dia. The process begins with feeding the wire to a standard boltmaking machine. The first step in the boltmaker is the shearing of a blank of the desired length. The blank then moves to the first heading station, and the head end is given an initial upset while the opposite end is centered and recessed by a ball punch. At the second heading station the upsetting of the head is completed, and the socket is finish formed by a polished ball punch. The upsetting increases the thickness of the stem from 0.499 in. to about 0.510 in., and the head is upset to about 1.040 in. A radius of about 0.183 in. remains under the head. In the last step of the upsetting die, the head is trimmed to about 1.015-in. dia, removing the flash produced by the cold heading. The next station chamfers the socket end of the stem.

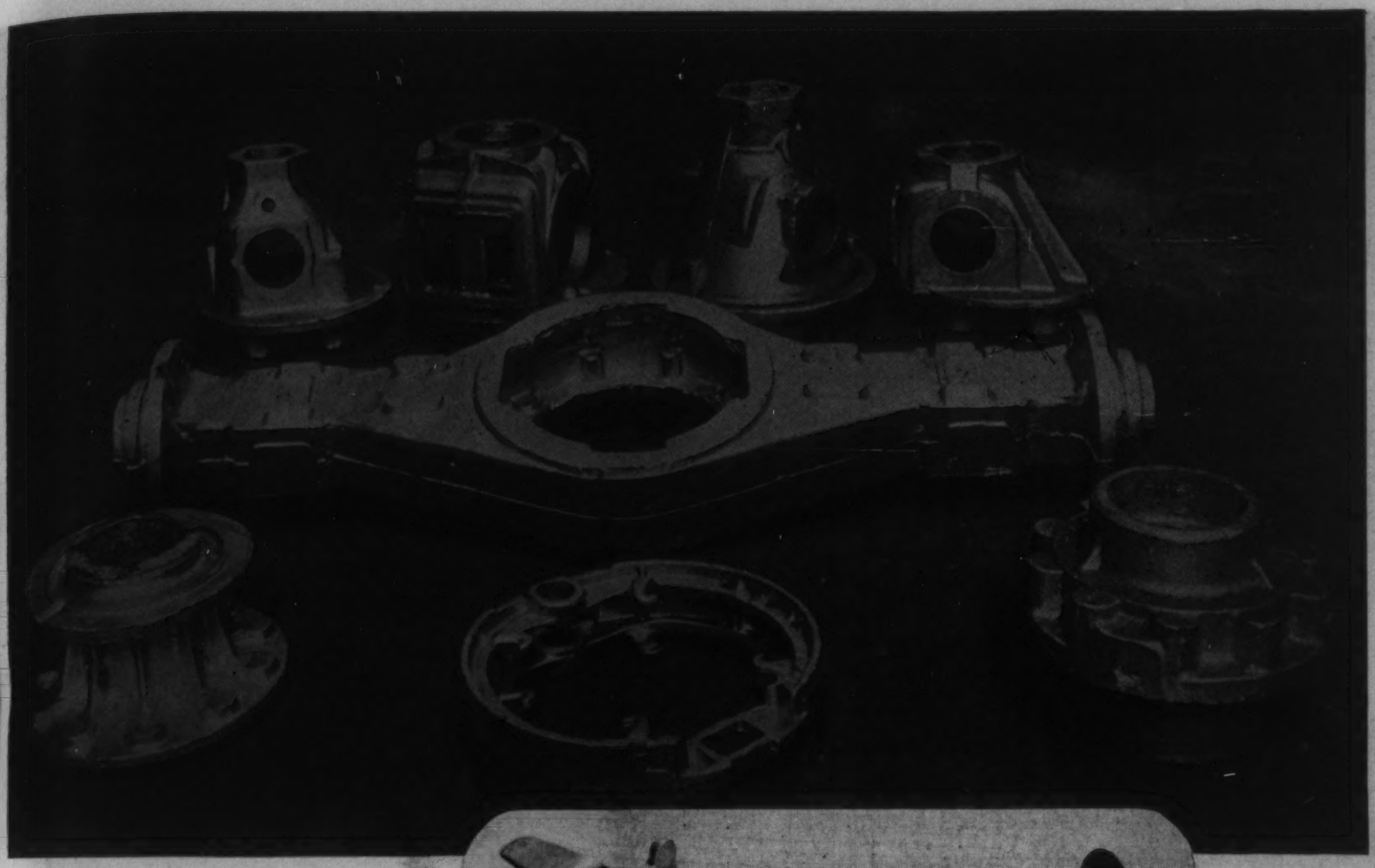
The next operation in the standard boltmaking machine ordinarily would be the transfer to the thread rolling dies and the rolling of the threads. The stem of the valve tappet is not threaded, of course, but this step is utilized to roll in a groove for grinding relief under the head of the tappet. The groove is about 0.007 in. under the stem diameter, and so could not be added in the heading dies. This completes the cold-forming operations.

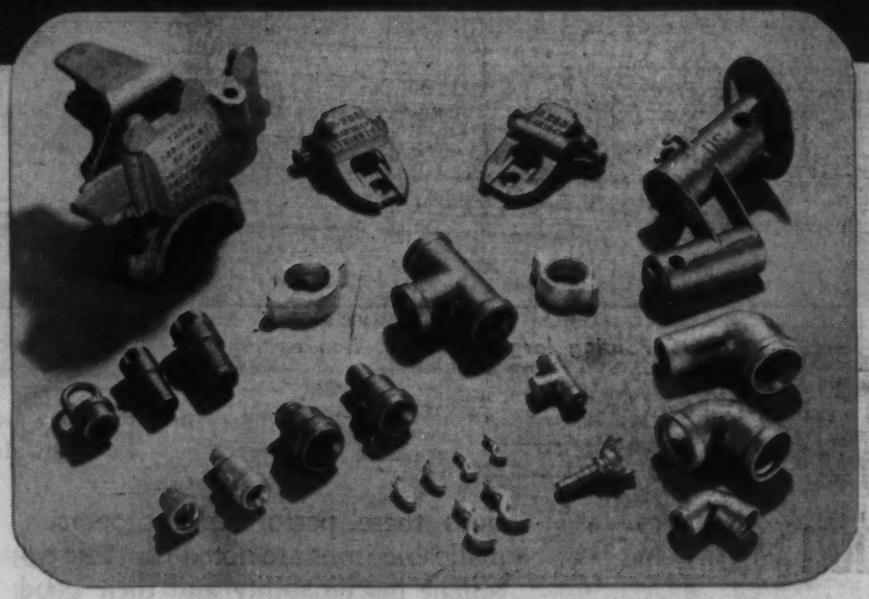
For the next operations, the tappet stem is rough ground, and the head is ground or machined to produce a slight crown on it. This crown is 0.002 in. max.

Tappets are then carbonitrided at 1650 F for 12 hr in an atmosphere of combusted gas to which propane and ammonia are added. A case 0.040- to 0.060-in. deep is produced, with 0.003 to 0.004 in. of carbides as cementite. At the end of the carbonitriding cycle the pieces are quenched in oil from a temperature of about 1540 F. Hardness is 58 Rockwell C in the finished pieces. A final heat treating operation is performed at 350 F, and serves as a slight stress relieving rather than a tempering step for the tappets.

Final operations are the finish grinding of the stem and the honing of the crown to produce a smooth surface. A finish of 12 microinches average roughness is obtained on the stem of the tappet, and the crowned surface of the head is honed to 6 microinches. Out-of-round of the stem is held to less than 0.0003 in., and the face must be square with the axis of the piece to within 0.001 in.

The company's engineers have already decided to make a minor change in the process so as to obtain satisfactory results from a lower-cost material. By adding a wire drawing stand at the feed end of the boltmaking machine, the coils of steel wire can be bought in a slightly larger size in the hot drawn state, drawn down to the present size at the machine, then fed to the boltmaking machine in the resulting cold drawn condition. The material supplied to the cold heading operation would be the same as at present, but the difference in mill price between the hot drawn and the cold drawn steel wire, less the cost of the new operation, could be saved. As the wire would be fed to the boltmaking machine immediately after the cold drawing, there would be no hardening of the steel, resulting from the cold drawing, to such a degree as to cause processing difficulties.





Malleable Iron Castings

by H. R. Clauser, Managing Editor, Materials & Methods

MATERIALS & METHODS
MANUAL No. 92

This is another in a series of comprehensive articles on engineering materials and their processing. Each is complete in itself. These special sections provide the reader with useful data on characteristics of materials or fabricated parts and on their processing and applications.

MARCH 1953

Malleable iron castings are useful engineering materials which in the past have not received the attention they deserve. Their unusual combination of properties, including excellent toughness, corrosion resistance, machinability and castability suit them for a wide range of uses. Therefore, the purpose of this article is to familiarize engineers and designers with the properties, characteristics and uses of the various types of malleable castings. The information includes:

- ***Types of Malleable Irons***
- ***Engineering Properties***
- ***Design Adaptability***
- ***Processing Characteristics***
- ***Applications***
- ***Directory of Producers***

Pouring large malleable iron castings. (Dayton Malleable Iron Co.)

Introduction

Malleable irons and the castings produced from them are useful engineering materials in many fields of industry. Although about half the production goes to the automotive industry, considerable quantities are used in such diverse fields as ordnance, aircraft, hardware and appliances, railroad equipment, machinery, and electrical and power equipment.

The successful application of malleable iron castings in such a broad range of uses is primarily due to their unique set of properties. Among their most useful characteristics are high toughness and ductility, and high resistance to atmospheric corrosion. Besides these performance properties, malleable irons are noted for their excellent machinability and their good casting properties which make possible sound castings in complicated as well as simple forms over a wide range of weights and sizes.

What Is Malleable Iron?

Malleable iron is an alloy consisting largely of an iron (ferrite) matrix in which are dispersed nodules of free carbon. This iron is sometimes called "American malleable iron" or "standard malleable iron". It must not be confused with the white iron first obtained from the mold after casting. This white iron, which is a hard, brittle combination of cemetite and pearlite, is converted to tough, ductile malleable iron by an annealing process.

Confusion also sometimes exists between malleable iron and white heart malleable iron. White heart malleable, which is produced in Europe and not used in this country, is composed of ferrite and considerable amounts of combined carbon. Among other differences it has lower ductility than standard malleable iron, and in heavy sections is likely to be hard and brittle in the center. Malleable iron is also frequently erroneously considered to be a type of gray iron. Although it is true that graphite is present in both malleable and gray iron, its form is quite different in the two materials. Graphite is present in gray cast iron in the form of flakes, whereas in malleable iron it is present as round nodules. Largely because of this difference in metallurgical structure the service properties of the two materials are also considerably different.

In the same general class of materials as the malleable irons just discussed, are the pearlitic malleable

Huge hydraulic press forms a malleable iron air brake housing to final dimensions. (The Eastern Malleable Iron Co.)

irons. They are made from about the same compositions and by essentially the same methods as standard malleables. Pearlitic malleable irons, however, differ in that the carbon is present in various combined forms and thus provide increased strength and wear resistance, but lower ductility.

These two types of malleable irons, along with their properties, characteristics and applications, will be covered in this Manual. To avoid confusion between them, the term "malleable iron" will refer to the standard malleable irons unless otherwise stated.

How Malleable Iron Castings Are Made

The melting and casting procedures generally used in ferrous foundries apply to the manufacture of standard and pearlitic malleable irons. Raw materials, consisting of pig iron, sprue and scrap, are melted and poured into sand molds. The resultant white iron castings are cleaned, after which they are then given an annealing treatment to convert them to malleable iron.

Annealing of standard malleable irons involves two stages. First is the breaking-up of the combined carbon in the iron. This is accomplished by heating to between about 1550 and 1750 F and holding there for a given length of time, depending on such factors as iron composition, maximum section thickness, and temperature. The second part of the annealing process is the precipitation of temper carbon. To do this the casting is held or slow-cooled through a temperature range of from about 1400 down to 1300 F. The time depends upon the same factors mentioned above. Total time required for the complete annealing cycle varies widely—from as much as 100 hr to as little as 12 hr.

Several different methods are employed to convert white iron to pearlitic malleable iron castings: (1) The second stage of the annealing process can be shortened to arrest the precipitation of temper carbon. (2) The precipitation of temper carbon can be prevented or retarded by adding a suitable alloying agent or by quenching and reheat treatment. Or a combination of alloy and quench can be used. (3) The regularly annealed malleable iron casting can be heat treated by reheating to above the critical temperature and either quenching or regulating the cooling rate. If quenched, the casting is usually tempered.

After the conversion heat treatments, the castings are cleaned, and gates and irregularities are removed. Warped castings are straightened either with hand hammers or presses.

Types of Malleable Iron

There are two major classes or types of malleable iron. First, and most important from the standpoint of production volume and use, is standard malleable iron. The second is pearlitic malleable iron. In addition to these, a relatively small percentage of alloy malleable iron is made to meet specialized requirements. Also, cupola

malleable, of lower physical properties, is produced by pipe fitting manufacturers for use in their smaller sizes of pipe fittings. Its scope of use is relatively limited, and, therefore, will not be covered in this Manual.

Table 1 lists the established standard and pearlitic grades of malleable iron, along with their general composition ranges and applicable specifications. The designations given to standard and pearlitic malleables by the American Society for Testing Materials are one of the most widely used in the industry; they, therefore, will be used throughout this Manual. In addition to established grades, there are some special malleable compositions commercially available, for many foundries produce one or more grades, under their own trade names.

It should be noted that standard and pearlitic malleable irons are specified and bought on the basis of mechanical properties — usually ultimate tensile strength, yield point and elongation—and not on the basis of chemical analysis. Specification by composition could be misleading because the chemical analysis does not necessarily reflect the properties of the final casting.

Standard Grades

The bulk of all malleable iron castings are produced in the two standard grades given in Table 1. Standard malleable irons are composed of a ferrite matrix in which are interspersed nodules of carbon. As a class they have high toughness and ductility and excellent machinability.

Grade 32510—Of the two, this grade has the higher carbon content, ranging from 2.30 to 2.70. Because of this it is extremely fluid and, therefore, is most suitable for thin and/or intricate castings. Sections as thin as 1/32 in., in limited areas, can be successfully cast. It is usually not used for castings having thicknesses exceeding 1½ in. unless the metal is specially treated.

Grade 32510 has the following strength properties: ultimate strength, 50,000 to 52,000 psi; yield point, 32,500 to 35,000 psi; elongation, 10 to 18%. One of its outstanding characteristics is its excellent machinability. It finds wide automotive and general production use.

Grade 35018—Because of its lower carbon (2.00 to 2.45%) this grade has slighly higher strength and substantially higher ductility than grade 32510. The strength values are as follows: ultimate, 53,000 to 60,000 psi; yield point, 35,000 to 40,000 psi; elongation, 18 to 25%.

Grade 35018 is commonly used for sections from 3/32 to 2½ in., and occasionally for thicker castings. Grade 35018 is widely used for railroad castings as well as for certain automotive and other parts requiring the higher strength and ductility along with excellent machinability.

Pearlitic Grades

Although the production volume of pearlitic malleable castings is small compared to standard malleable, their use is rapidly increasing. Pearlitic malleable irons are produced either from the same white iron compositions as the standard grades or from compositions containing small alloying additions. They differ from the standard grades, however, in that some of the carbon is retained in combined form, because of a special heat treatment and/or the alloying addition. The combined carbon, existing in quantities of from 0.30 to 0.80%, is present in one of a number of forms, each of which imparts characteristic properties to the iron.

Pearlitic malleable castings are produced by (1) stopping the annealing heat treatment before all the combined carbon has been transformed, (2) by reheating standard malleable iron to above the transformation range and quenching, (3) by suitable alloy additions, and (4) by cooling standard malleable, after completion of first stage graphitization, at a sufficiently rapid rate through critical range to retain pearlite.

Table 1 gives the five grades which are covered by ASTM Specification A220 and which comprise the bulk of pearlitic malleable irons produced today. The principal difference between the various types and grades lies in the form in which the combined carbon is present.

The desirable properties in pearlitic malleable iron are largely a result of this combined carbon. In general, pearlitic malleables have higher strength, hardness, rigidity and abra-

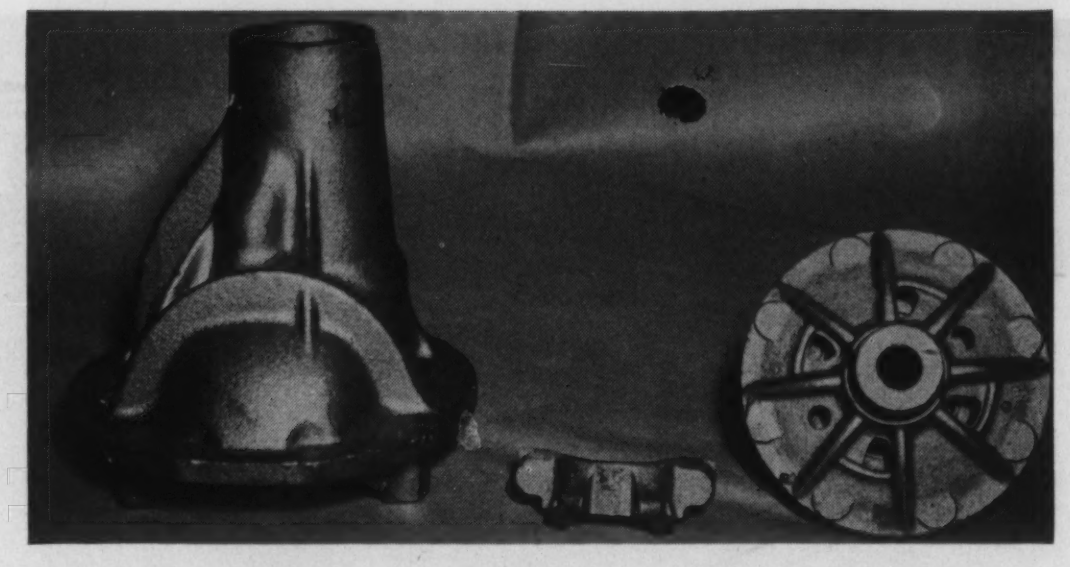
Table 1—Types and Grades of Malleable Iron

Type	Grade	Min. Ult Tens Str, Psi	Min. Yld Str, Psi	Min. Elong %	Composition, %					Applicable Specs. and Grades				
					C	Si	Mn	P	S	ASTM	SAE	U. S. Army	Army Ord.	Navy
Standard	32510	50,000	32,500	10	2.3-2.7	1.5-0.8	Under 0.55	Under 0.18	Under 0.20	A47-48	SAME AS ASTM	QQ-I-666a Grade B	—	46-I-8C B Zinc Coated
	35018	53,000	35,000	18	2.0-2.45	1.4-0.85	Under 0.55	Under 0.18	Under 0.20	A47-48		QQ-I-666a Grade A	—	46-I-8C A Black
Pearlitic	43010	60,000	43,000	10	Same as Standard Grades, Except That Manganese Can Be Higher					A220-50		—	AXS-623 E	—
	48005	70,000	48,000	5						A220-50		—	—	—
	53004	80,000	53,000	4						A220-50		—	AXS-623 B & D	—
	60003	80,000	60,000	3						A220-50		—	AXS-623 A & C	—
	70002	90,000	70,000	2						A220-50		—	—	—

sion resistance than standard grades. As a consequence, however, they have less ductility and shock resistance and are not as easily machined. Ultimate strengths of pearlitic malleable irons range between 60,000 and 90,000 psi and their yield strength between 40,000 and 70,000 psi. Their elongation ranges between 12 and 3%.

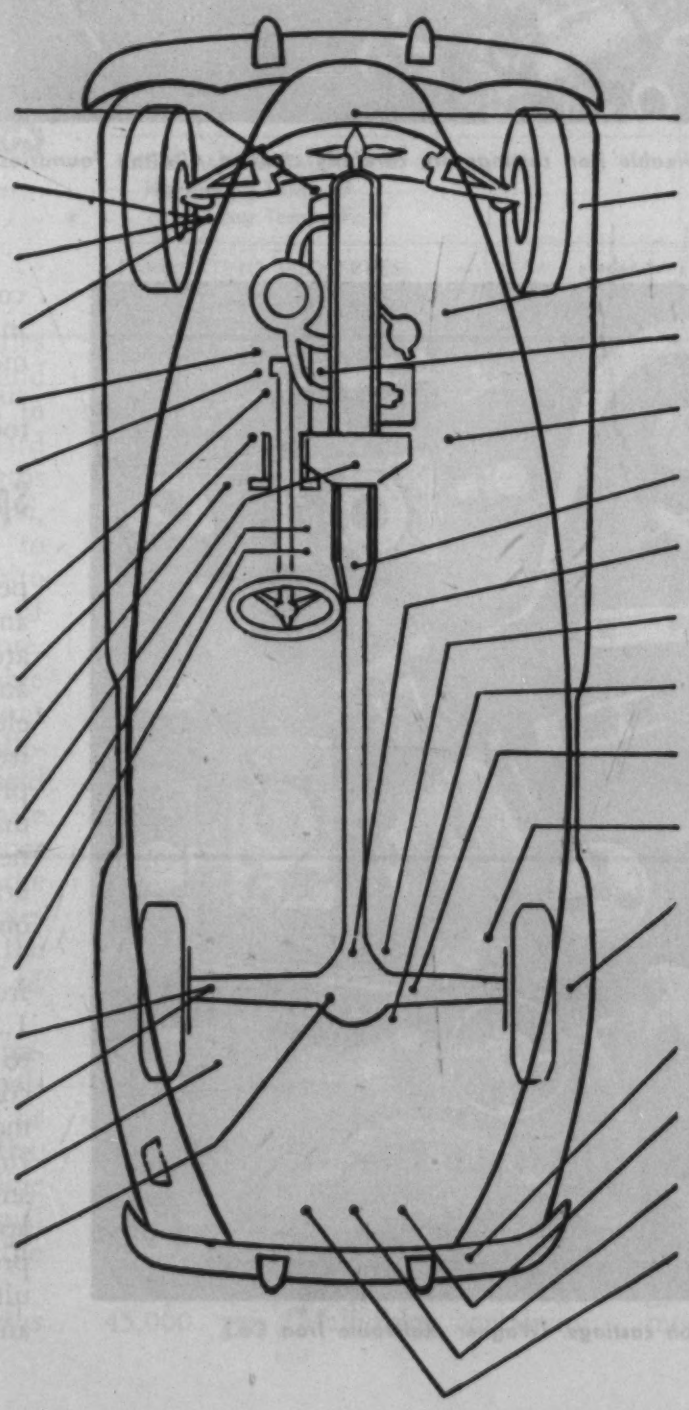
An important characteristic of the pearlitic types is that they are readily surface, local and through-hardened. This has widened their field of use considerably. (See section on heat treatment).

Pearlitic malleable castings are generally selected where superior wear resistance and/or relatively high strengths are required to meet service



This differential carrier, case and bearing cap used in passenger cars gives idea of range of sizes of malleable castings produced. (Dayton Malleable Iron Co.)

About 50% of all malleable iron castings are used in the automotive field. This diagram shows typical malleable parts used in passenger cars. (Lake City Malleable Co.)



Generator and Fan Supports
Shock Absorber Brackets
Shock Absorber Housings
Shock Absorber Liners
Steering Gear Cases
Steering Gear Brackets
Pedal and Master Cylinder Brackets
Pedal Brackets
Brake and Clutch Pedals
Shifter Forks
Steering Post Lock Bodies
Steering Post Brackets
Spring Seats
Spring Seat Caps
Spring Hangers
Rear Axle Housing

Radiator Inlets and Outlets
Hubs
Vibration Dampener Plates
Exhaust Pipe Flanges
Motor Supports
Transmission Brake Support
Differential Cases
Differential Carriers
Adjusting Nuts
Bearing Caps
Bearing Retainers
Combination Hub and Brake Drums
Bumper Brackets
Body Brackets
Spare Tire Lock Bodies
Spare Wheel Brackets

Malleable iron castings are carefully cleaned. (Dalton Foundries, Inc.)

Typical small malleable iron castings. (Wagner Malleable Iron Co.)

conditions. They are widely used in the automotive, agricultural equipment and ordnance industries, for such parts as gears, sprockets, air tools and rocker arms.

Special Malleable Irons

Compared to the standard and pearlitic malleable grades, only small amounts of special malleable irons are produced. Copper, molybdenum and silicon are the principal alloying elements used in special malleable irons. Special malleable irons are produced in the same way as standard malleables; they are completely annealed and derive their special properties from the effect of the alloying on the ferritic matrix.

Copper-Alloyed Malleable—These irons contain from about 0.25 to 1.25% copper. Amounts from 0.25 to 0.50 added to standard malleable compositions increase resistance to atmospheric corrosion, especially to sulfurous atmospheres. While these small additions of copper have no appreciable effect on the mechanical properties, larger amounts increase ultimate strength and yield point, and reduce elongation slightly. The

strengths of these irons can be further increased by a precipitation hardening treatment.

Copper-Molybdenum Alloyed Malleable—These alloyed malleable irons provide extra high strength without appreciable sacrifice of ductility. They have an ultimate of from 58,000 to 65,000 psi, a yield of 40,000 to 45,000 psi, and an elongation of 15 to 20%.

High Silicon Malleable—These irons usually contain 1.40 to 2.00% silicon. Total carbon and silicon is around 3.90%. The principal advantage of the silicon malleables is that they can be annealed in a relatively short time—in some cases in as little as 15 hr. The properties of these compositions are close to those of Grade 32510. Due to the graphitizing influence of silicon and possible formation of undesirable primary graphite in heavier sections, high silicon malleable is not cast in as heavy sections as is the normal silicon malleable iron.

Engineering Properties

Strength Properties

A summary of strength properties that may be expected in standard and pearlitic malleable irons is given in Table 2. In general, the standard grades have ultimate tensile strengths from about 50,000 to 60,000 psi, yield strengths of about 32,000 to 40,000 psi, and elongations of 10 to 25%. The ultimate strengths of standard malleable irons, therefore, are lower than those of comparable mild steel mill products, steel castings and drop forgings. However, malleable irons have relatively high yield point in relation to their ultimate strength, and exceed that of a number of steels. For design purposes, the yield strength of standard malleables is generally considered as 65% of the ultimate. With steels, values of around 50% are used.

Compared to steels, another unusual characteristic of standard malleable irons is that elongation or ductility improves at higher strengths. This, however, is not true of pearlitic malleables, which follow the usual pattern of the higher the strength the lower the elongation.

The ultimate and yield strengths of all pearlitic malleable irons are higher than the standard grades. Ultimate strengths commonly range from 60,000 to 90,000 psi, although some go as high as 100,000 psi. Their yield points vary from around 43,000 to 70,000 psi, and elongation from 12 to 3%. In the lower strength levels, yield strength is around 70% of the ultimate, but at the high strength levels, yield points range between 75 to 88% of the ultimate.

As pointed out earlier, additions of copper alone or in combination with molybdenum increase strength somewhat. The strengthening effect of copper increases with carbon content. A standard malleable composition with about 1.25% copper will provide an ultimate of 52,000 to 60,000 psi and yield point of 38,000 to 45,000 psi. Malleables containing 0.75% or more copper can be given a precipitation hardening treatment to increase strength another 10,000 to 15,000 psi. When both copper and molybdenum are added to suitable compositions they provide ultimate strengths of 58,000 to 65,000 psi, yield strengths of 40,000 to 45,000 psi, and elongations of 15 to 20%.

Since the final properties of malleable iron castings are a result of a long cycle heat treatment, the section thickness has no appreciable effect on strength properties. Therefore, strength properties will be approximately the same throughout the entire section.

Ultimate strength in shear of standard malleable irons is about 90% of the ultimate strength. Because of the ductility of malleable iron, it has good compressive strength. The modulus of elasticity in compression

Table 2—Typical Properties of Malleable Irons

Type	32510	35018	Pearlitic Grades
PHYSICAL PROPERTIES			
Density, Gm/Cu Cm	7.20-7.31	7.20-7.31	7.20-7.31
Thermal Cond., Gm/Cal/Sec/Sq Cm/Cm/C			
@ 80 F	0.122	0.122	(1)
@ 700 F	0.095	0.095	(1)
Coeff. of Exp. per F, In. per In.: 68 to 750 F	0.0000066	0.0000066	(1)
Mean Spec. Ht., Calories/Gm/C (70 to 750 F)	0.133	0.133	—
Elect. Res., Microhm-Cm @ 68 F	32.0	32.0	38.19 to 41.17
Spec. Volume, Cu Cm/Gm/ @ 68 F	0.1366	0.1366	0.1366
Shrinkage Allowance (Contraction Minus Expansion During Anneal)	11/64-1/32	11/64-1/32	11/64-1/32
Magnetic Properties	Magnetic	Magnetic	Magnetic
MECHANICAL PROPERTIES			
Mod. of Elasticity in Tension, Psi	25 x 10^5	25 x 10^5	28 x 10^5
Tensile Str., 1000 Psi	50-52	53-60	60-90
Yield Str., 1000 Psi	32-35	35-40	40-70
Elongation in 2 In., %	10-18	18-25	12-3
Reduction of Area, %	18-23	18-23	—
Hardness, Bhn	110-145	110-145	160-285
Impact Str., Izod, Charpy, Ft-Lb (V-Notch 0.079 In. Deep, 0.394 = In. Sq Bar)	16.5	16.5	12
Fatigue Str., (End. Limit), 1000 Psi	25	31	30-32
Endurance Ratio	0.50	0.50	—
Modulus of Elasticity in Compression	25 x 10^5	25 x 10^5	28 x 10^5
Compressive Yield Str., 1000 Psi:			
1% Perm. Set:	28	28	43
At Failure:	90+	90+	—
Ult. Shear Str., 1000 Psi	45-48	48-54	—
Yield Str. in Shear, 1000 Psi	29-32	32-36	—
Mod. of Rupture in Torsion, Psi	58,000	58,000	—
Poissons Ratio	0.17	0.17	—
Allowable Working Stress at 775 F, Psi	5600	5600	—
THERMAL TREATMENT			
Hardening Temp., F	1500[2]	1500[2]	1500
Tempering Temp., F	—	—	About 600
FABRICATING PROPERTIES			
Casting Temp. Range, F	2600-2800	2600-2850	2600-2850
Machinability Index (B1112 Steel = 100)	120	120	80-90
Weldability	Not fusion welded. Can be soldered and brazed.		

NOTES:
(1) Estimated to be somewhat higher than standard grades.
(2) Must be first heated to 1700 F to dissolve graphitic carbon.

for standard malleable is 25 x 10^5, which is close to that in tension. In tests up to 90,000 psi, although malleable iron specimens took a permanent set of 1% at about 28,000 psi, no failures occurred.

Both under compressive or transverse loading, standard malleable iron seldom actually fails by fracture. Rather, it flows almost indefinitely, and under compressive or transverse stresses will usually become unserviceable by deforming rather than failing by fracture.

Hardness

Brinell hardness of standard malleable irons varies from about 110 to 145, but the usual range is from 115 to 135. Pearlitic malleable and alloyed grades have higher hardness ranges —from about 160 to 285 Brinell hardness.

The hardness, like strength properties, is uniform from surface to center of a casting. Both hardness and tensile strength increase with combined carbon content.

Impact Resistance

One of the outstanding characteristics of standard malleable iron is its excellent toughness, which provides high impact resistance. For this reason it is widely used in applications where the part must resist shock loading. As measured by standard Charpy and Izod impact tests, impact resistance of standard grades ranges from about 12 to 17 ft-lb.

The high impact resistance of standard malleable is well demonstrated by the so-called wedge test. The test piece, 6 in. long, 1 in. wide and tapering from ½ in. thick at one end to 1/16 in. at the other, is held at the base and subjected to 70 ft-lb blows by a hammer. Under these blows the material will bend and curl as shown in the accompanying illustration. On the average, standard malleable grades will withstand 20 to 30 blows before failure.

Since elongation or ductility of pearlitic grades is lower than standard grades, it would be expected that impact resistance is also lower. From the little test data available it appears that Charpy and Izod values range around 12 ft-lb.

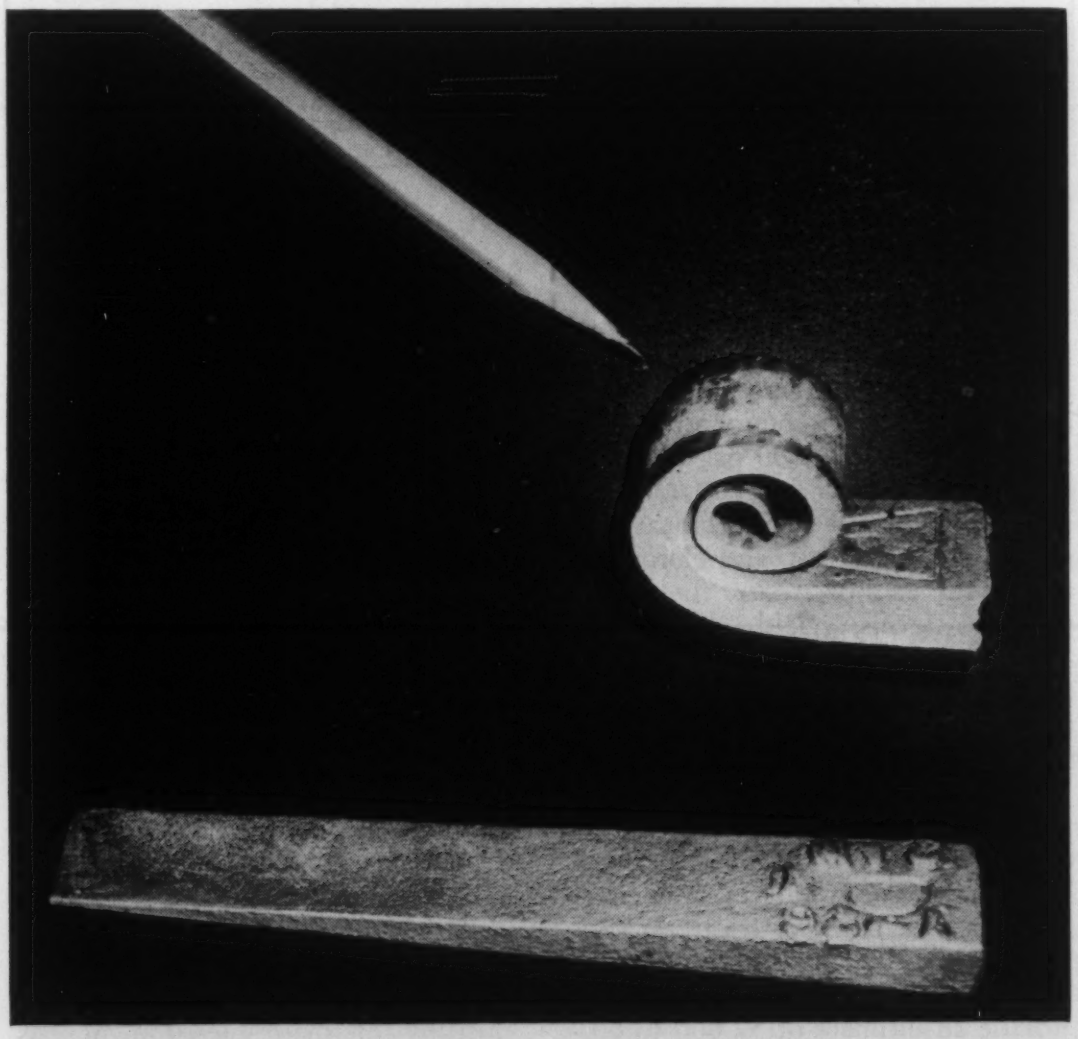
At sub-zero temperatures, all irons and steels lose some toughness. However, at temperatures as low as –50 to —80 F, both standard and pearlitic malleable iron shows less embrittlement than most other ferrous materials.

Fatigue Strength

The fatigue strength of standard malleable iron compares favorably with that of other cast and wrought ferrous materials. Results of rotating beam tests give an endurance limit of around 32,000 psi for ten million cycles. The endurance ratio (ratio of endurance limit to ultimate strength) is generally considered to be about 0.50 to 0.58.

Recent tests have indicated that malleable iron is less sensitive to notches than are most ferrous alloys. Notch sensitivity expressed as the ratio of notch-fatigue strength to ultimate strength is 0.33 or 33%. Thus, a malleable iron having an ultimate of 55,000 psi will have a notch fatigue strength of 18,000 to 20,000 psi. Notch sensitivity is further improved by shot blasting or cold working the metal surface at the areas of stress concentration.

There is little information on the fatigue strength of pearlitic malleable irons. However, pearlitic malleable compared favorably with forged steel in fatigue tests on crankshafts.



"Curl" test demonstrates excellent toughness of malleable iron. The wedge, bottom, was struck 30 blows of 70-ft-lb each without fracture, as shown at top.

Elevated Temperature Properties

Since the carbon present in malleables dissolves at temperatures above about 1400 F, malleable iron castings should not be used above 1200 F. Tensile strength properties change very little up to about 600 F; between 600 and 800 F they begin to decrease; and above 800 F they drop sharply, until at 1200 F tensile properties are approximately 20 to 25% those at room temperature. Elongation also remains practically constant up to 600 F, but above this temperature it increases rapidly. For design purposes an allowable working strength of 5600 psi at working temperatures up to 775 F is generally used.

Malleable iron has excellent stability at elevated temperatures. Tests indicate that up to 900 F there is practically no growth or permanent increase in volume except under re-

peated heating. And between 900 and 1200 F there is only a slight growth.

Impact resistance, as measured by Charpy tests, is not appreciably changed up to about 400 F. In some cases impact resistance may be lowered if castings are heated to 850 or 900 F and quenched, as in the hot dip galvanizing process. This galvanizing embrittlement can be prevented by quenching the malleable castings from 1200 F when they are produced, or by keeping phosphorus low.

Corrosion Resistance

The corrosion resistance of malleable irons under common weathering conditions, water and salt water is better than medium carbon steel and wrought iron. This is due to the fact that malleable iron castings have a thin 0.008- to 0.010-in. skin of ferrite which is highly resistant to most ordinary atmospheric conditions and salt water. Even after machining, the ferrite matrix still provides good corrosion resistance. Under stress, malleable also shows less tendency to crack than some corrosion resistant irons. Malleable irons are widely used in outdoor installations such as pole line hardware, architectural railings, railroad rail braces, railroad car hardware, pipe flanges, highway guard rail brackets, anchors, farm implement parts, etc.

Copper alone and in combination with molybdenum is used in malleable irons to improve resistance to atmospheric corrosion. Copper additions, in particular, improve malleable's resistance to sulfurous atmospheres. In alloyed malleables, copper up to 2.00% improves resistance to corrosion by flue gases.

Copper additions also increase corrosion resistance of pearlitic malleable irons. Thus, pearlitic malleables containing copper are widely specified for parts such as valve bodies, pump parts, chain links and elevator buckets, where corrosion is involved.

Table 3 shows the results of an exposure test which demonstrate the good corrosion resistance of malleable irons to locomotive smoke. The test specimens were suspended in the smokejack of a round house in continuous use. It was found by comparison with identical specimens in railroad service that the corrosion resulting on specimens in the smokejack over a period of one month was equivalent to the corrosion resulting in two years on metals in service. From the table it can be seen that malleable iron with 1% copper showed the lowest loss, and standard malleable iron the second lowest.

Bearing Properties and Wear Resistance

Of all the malleable irons, the pearlitic grades have the highest wear resistance. They find satisfactory use in lubricated bearing and dry bearing applications. They are also used for abrasion resistant parts such as gears, camshafts, sprockets, chain links and rollers of various types. Hardened pearlitic malleable iron is frequently specified for gears. When heat treated to a Rockwell C hardness of 56 to 58, it is reported to be equal or superior to carburized steel in wear resistance.

Although in general they cannot compare with the commonly used bearing metals, such as the white metals and copper-base alloys, certain pearlitic malleables find use as bearings. They have excellent nongalling properties in metal-to-metal contact, and in some cases have replaced bronze bushings.

Standard malleable irons, like most other metals, perform satisfactorily as long as there is an unbroken lubricating film and no abrasive particles larger than the film thickness. If the lubricating film fails, the temper carbon can aid lubrication. But if bearing load and/or speed are high, welding or galling results, because of the soft ferrite matrix. Therefore, standard grades are only applicable where bearing pressure and speeds are low. For higher pressures the malleable iron is lined with a thin layer of bronze or other bearing metal.

Table 3—Resistance to Smoke Atmosphere

Material	Shape of Specimen	Average Loss per Month (Oz per Sq In.)
Standard Malleable Iron	Flat	0.00545
Standard Malleable Iron	Round	0.00650
Malleable Iron with 1% Copper	Flat	0.0044
Malleable Iron with 1% Copper	Round	0.0058
Wrought Iron	Flat	0.0076
Wrought Iron	Round	0.00716
Basic Open-Hearth Steel	Round	0.00777
Commercial Pure Iron	Round	0.0087

Damping Capacity

Standard malleable irons castings possess excellent damping capacity and, therefore, are well suited for applications where the part must resist motion and absorb energy within itself. Pearlitic malleable irons also have high damping capacity. Their ability to restrict vibration has led to their adoption for such parts as camshafts.

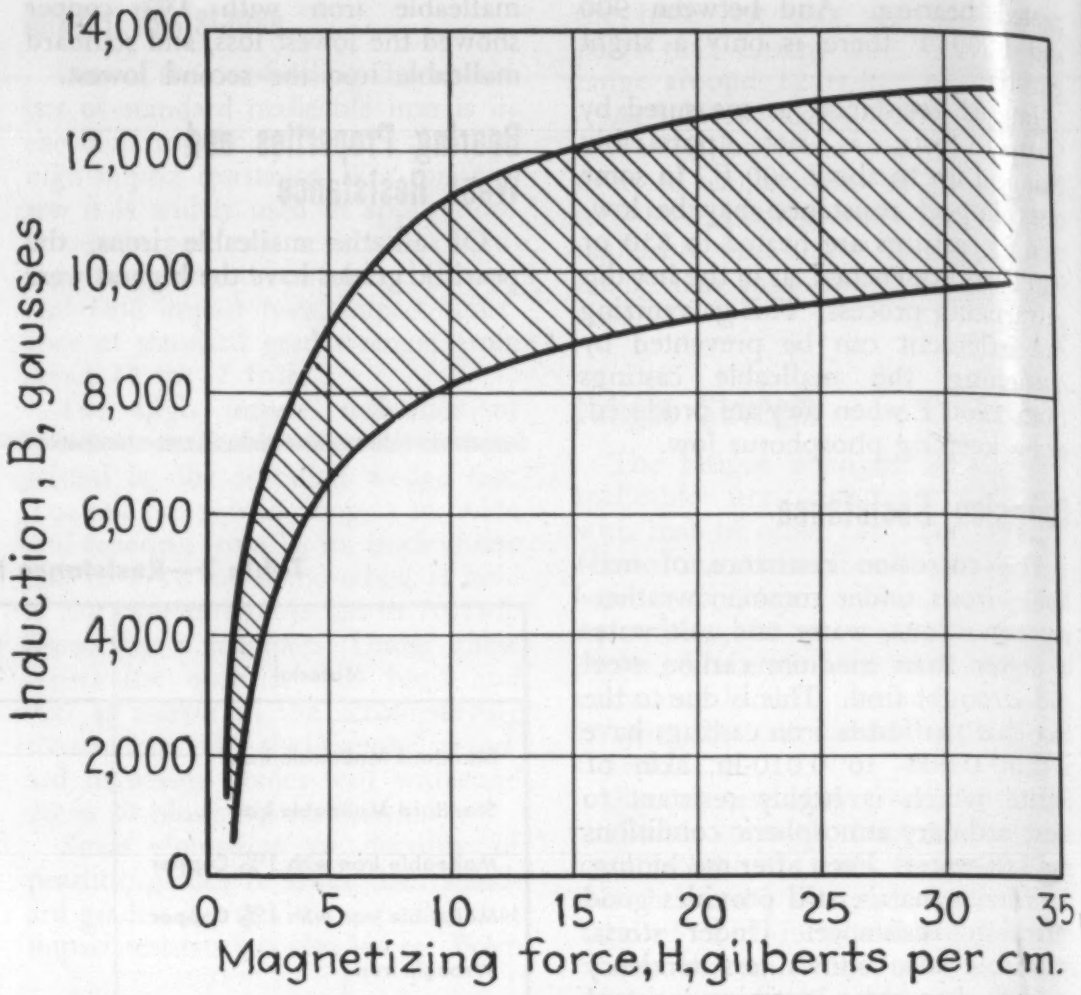
Magnetic and Electrical Properties

Because of the very small amounts or the absence of combined carbon, standard malleable irons have desirable magnetic properties. Both hysteresis loss and coercivity are low. The coercivity values range from

about 1.15 to 1.55 amp turns per centimeter. The accompanying chart shows the range in which the magnetization curves fall for malleable irons. An indication of the magnetic permeability (ratio of induction to magnetizing force) can also be obtained from this chart.

Because of the combined carbon in pearlitic malleable irons, their magnetic properties do not compare with those of standard grades. The coercivity values are from 7.85 to 12.55 amp turns per centimeter. Their magnetic permeability at 200 amp turns per in. is around 80 compared to around 400 for standard malleable irons.

The electrical resistivity of standard malleable irons averages around 32 microhms per centimeter cube. For pearlitic malleables, the electrical resistivity is around 40 microhms per centimeter cube.



Shaded area shows range in which magnetization curves fall for malleable irons.

Design Adaptability

Of the ferrous casting metals, malleable iron rates high in design adaptability. Because of its good fluidity, malleable iron can be cast in thin sections and in complicated shapes. Intricate castings having many flanges and different section thicknesses are relatively easily produced. In addition, its high fluidity and uniform structure provides uniform strength and toughness, so that metal can be placed in the exact section thickness and location desired.

Shapes, Sizes, and Thicknesses

Approximately 75% of all malleable castings produced do not exceed about 18 in. in length and 25 lb in weight. And of this percentage, the majority of castings do not weigh over 10 lb. Large quantities are produced weighing less than 1 lb.

From the above it should not be concluded that larger castings cannot be made or that thick sections cannot be completely and uniformly malleabilized. On the contrary, sections up to at least 4 in. thick can be completely malleabilized using normal cycles, and castings weighing 400 lb or more are produced commercially. However, due to the possibility of obtaining primary graphite which adversely effects strength and toughness, castings having sections over 4 in. are generally not specified for malleable iron.

In general, malleable iron castings are produced with section thicknesses from 1/16 in. to 2 in., although, as indicated above, castings up to around 4 in. are sometimes made. Sections of 1/2 to 3/4 in. are very practical for medium size castings; 3/16- to 1/4-in. sections with strengthening ribs properly designed and located are practical for the thinner castings. The thinnest section that can be cast satisfactorily depends on design of the part and the pattern equipment. Using quality patterns and uniform sections, castings as thin as 3/32 in. are possible.

As with all castings, uniform section thickness and all sections as nearly equal as possible are preferable. When two sections of unequal thickness meet, the thinner one should be at least 1/4 that of the thicker section. Also, with sections of unequal thickness, taper design and fillets are generally required. A tapered section is recommended when the thinner section is between 1/4 and 3/5 the thickness of the thicker section.

From the above, it is evident that within reason and using proper design, light and heavy sections may be present in the same casting. One example is an automotive differential carrier casting, weighing about 20 lb, which has bearing seats consisting of 1 1/4-in. cubes, while some of its wall sections and ribs are not over 1/4-in. thick.

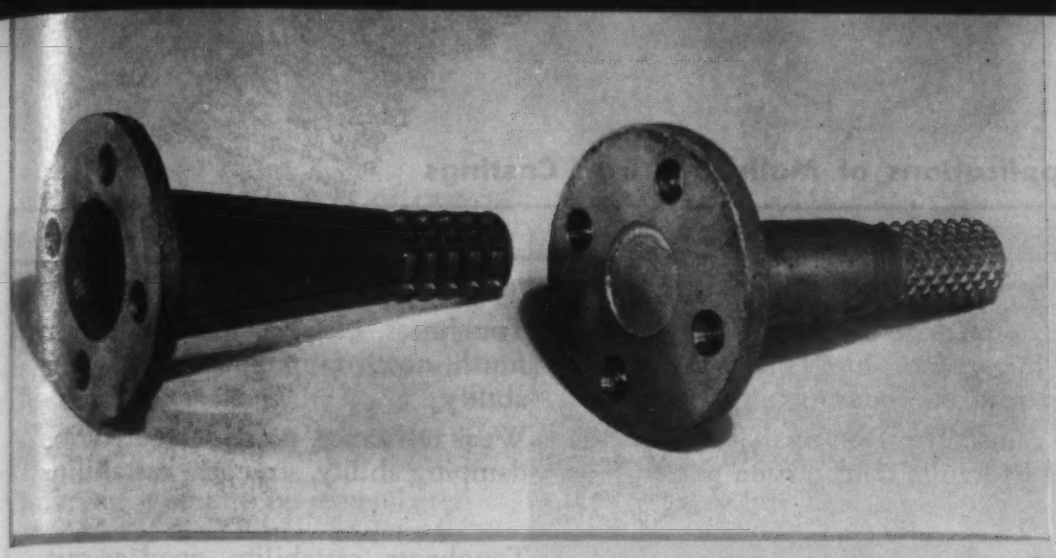
With malleable iron, holes and interior cavities can readily be obtained by coring. The relatively small additional cost of cores is usually well offset by savings realized through a reduction or elimination of machining. Holes can also be made in malleable castings by punching. Such holes, however, are generally limited to diameters no greater than the section thickness.

Flat plate sections are readily produced in malleable iron. The minimum practical area of the plate in any case is determined by the amount of sand that can be tolerated on top of the mold without sagging.

Accuracy and Tolerances

In general, malleable iron castings can be produced with dimensional accuracy equal to or better than other ferrous sand castings. Because of their relatively smooth as-cast finish, malleable castings are frequently cast to finished dimensions, eliminating further machining.

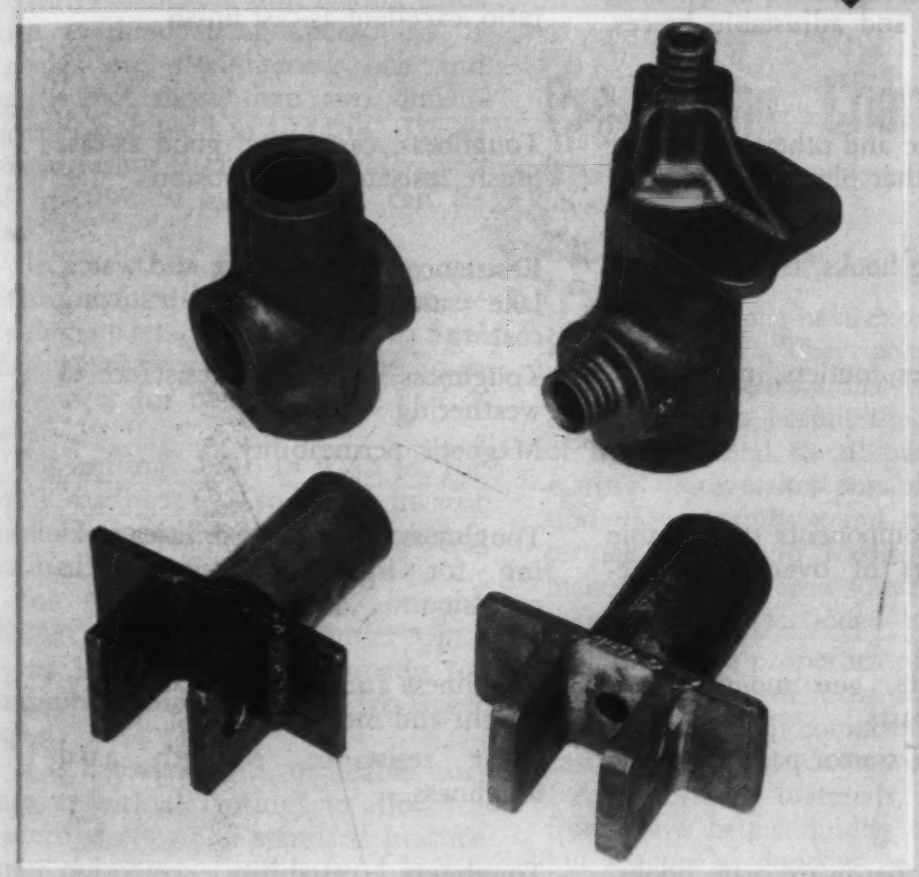
TYPICAL REDESIGNS

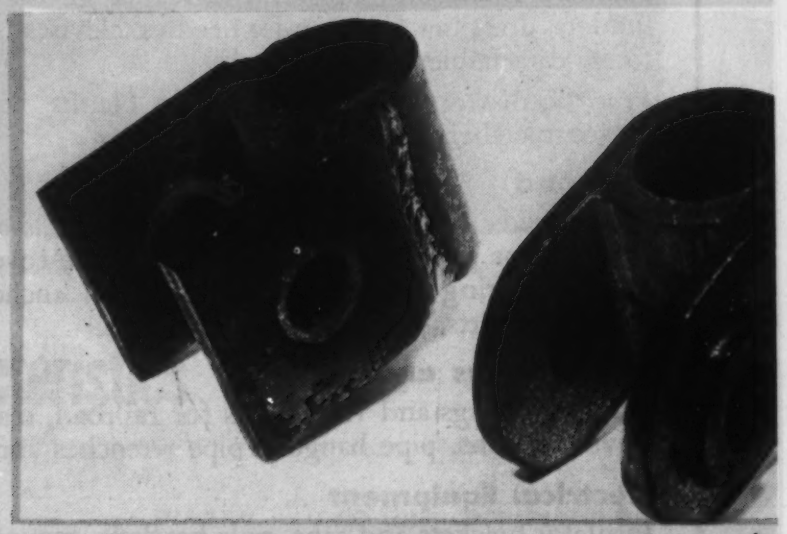


***INSULATOR BRACKET** now made of malleable iron (left) was formerly a solid formed piece. The redesign resulted in 38% lighter weight, improved corrosion resistance, greater ease of handling, assembly and mounting, and lower cost.*

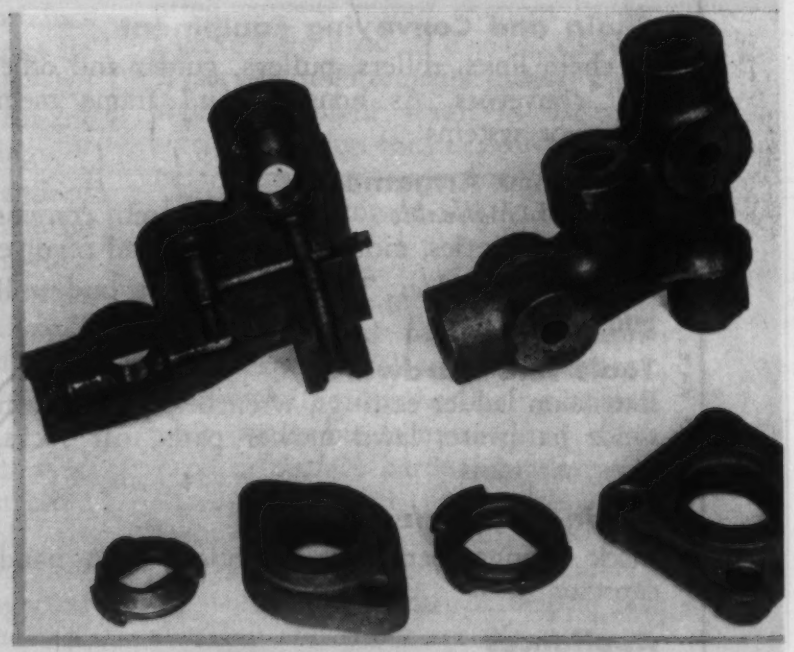
***CAR BRINE VALVE** (top). Formerly composed of two gray iron castings, this valve was effectively designed as a one-piece malleable casting.*

***ELEVATOR CONTROL MECHANISM PART** (bottom). Originally, part was built up from one piece of steel bar stock and three flat pieces (left). Conversion to a one-piece malleable casting resulted in a better looking part, lower weight, easier machining, and lower cost.*

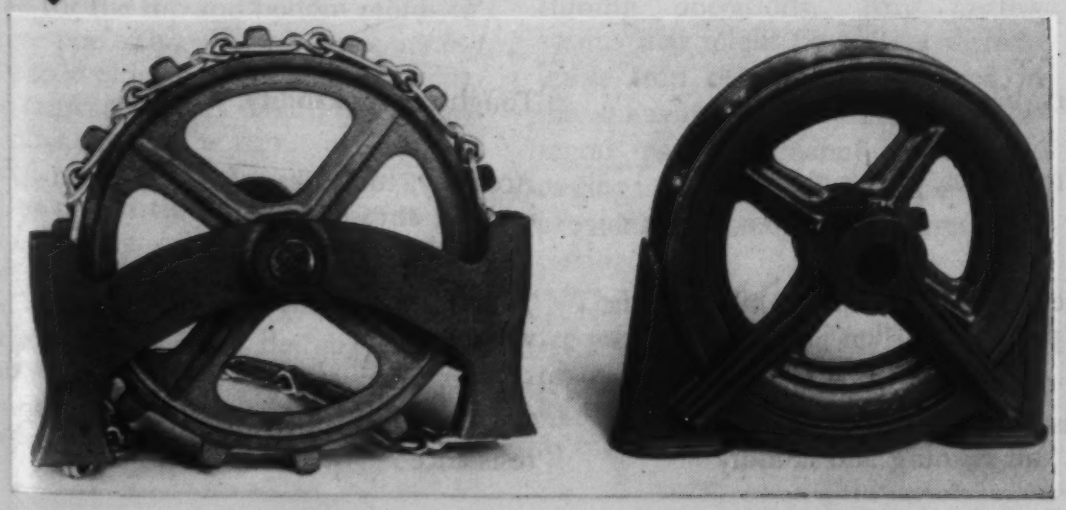




***PLOW SWIVEL** was formerly fabricated by welding using four separate pieces (left). The part was redesigned as a malleable iron casting. Weight of malleable iron design was 2 lb as compared to 2½ lb for welded assembly.*



***WHEEL AND CHAIN ASSEMBLY** now made of malleable iron (left) weighs only 8 lb compared to 15½ lb for former cast assembly. Other advantages gained include better shock resistance, improved design and lower cost.*



***HYDRAULIC PRESS VALVE** (top). Cross-section (left) is of the valve machined from forged steel. In changing over to malleable iron, all holes were cored, requiring only light final machining with a consequent saving in machining cost of 80%.*

***VALVE STOP COLLARS** (bottom). Originally forged, they were redesigned for malleable iron castings to incorporate all the desired design elements, to eliminate much machining, to use less metal, and to achieve lower cost.*

Typical Applications of Malleable Iron Castings

Use	Main Reasons for Use*
Automotive	
Standard Malleable: Differential gear cases, carriers, bearing caps, steering gear housings, pedals, pedal brackets, hubs, door hinges, truck spring hangers, hubs, brake supports, shoes and rear axle housings	Toughness, castability, good as-cast finish, notch fatigue ratio, damping ability
Pearlitic Malleable: Valve rocker arms, camshafts, Universal joint yokes, hydraulic steering gear pistons, automatic hydraulic transmission parts	Wear resistance, notch fatigue ratio, damping ability, strength, castability
Agricultural Equipment	
Standard Malleable: Mower and reaper guards and shoes, housings, load binders, draft brackets, binder-needles, clevises, swivels, dehorners and hay tools, detachable chain	Toughness, castability, good as-cast finish, resistance to atmosphere and weathering
Pearlitic Malleable: Cast gears, gear blanks, bearing housings, sprockets, detachable chain, picker and husker parts	Wear resistance, notch fatigue ratio, strength, castability, damping ability
Railroad	
Brake heads and fulcrums, hand brake wheels and housings, side bearing braces, door fixture castings, tank car dome covers, rings, valves, slabbing castings, spring plates, water scoops, rail anchors and adjustable braces, draft gear parts, journal boxes and lids	Toughness, resistance to atmosphere and smoke, castability, notch fatigue ratio, excellent as-cast finish
Pipe Fittings and Parts	
Flanges, fittings and valve parts for railroad, marine and other heavy duty service, unions, pipe hangers, pipe wrenches and other plumbing tools	Toughness, castability, good as-cast finish, resistance to corrosion
Electrical Equipment	
Insulator brackets and caps, pole brackets, mounting hooks, earth anchors	Resistance to weathering and water, take excellent hot dip galvanizing coating
Bushings, pipe and cable hangers, junction boxes, outlets, motor and generator parts	Toughness, castability, resistance to weathering
Parts in magnetic circuits	Magnetic permeability
Chain and Conveying Equipment	
In chain links, rollers, pulleys, guides and other components of movable belt conveyors. As housings and frame members of overhead crane-conveyor systems	Toughness, design possibilities making for lightness, resistance to corrosion
Ordnance Armament	
Standard Malleable: Shell and bomb components, gun mounts, base pedestals, pintles, mortar parts, gun and revolver parts	Toughness and strength, castability, weight and metal saving
Pearlitic Malleables: Tank track guides, body rollers, tractor parts, machine gun parts	Wear resistance, strength and toughness
Tools and Hardware	
Extension ladder castings, wrenches, pliers, harness hardware, gate hooks, fence hardware, lawn mower parts, oar locks, door hardware, casters, vises, air tools	Toughness, castability, corrosion resistance
Marine Equipment	
Deck fittings, oar locks, anchors, cargo handling parts, towing bitts, capstans	Resistance to smoke, water and salt atmosphere, toughness
Appliances	
Parts in stoves, refrigerators, washing machines, fans, automatic stokers, sewing machines	Toughness, castability
Business Machines	
Escapement frames, carriage release levers, bars, stops	Toughness, castability
Machine Tools	
Parts for lathes, planers, shapers, screw machines, gear cutters, etc.	Accuracy, toughness, freedom from internal stresses
Highway and Bridge	
Road joint supports, brackets, turnbuckles, anchors, drainage inlets, traffic markers, guard rails, bridge railings and posts, expansion joints	Toughness, castability, resistance to weathering
Processing Machinery	
Parts for machinery used in such industries as: textile, cement, rubber, mining, quarrying, foundry, oil drilling and refining and laundry	Toughness, weather resistance, wear resistance

* In most of the applications listed, the excellent machinability of malleable iron is used to advantage.

In general, size tolerances of castings are considered to be one-half the maximum shrinkage allowance. For malleable castings the net shrinkage allowance (shrinkage of white iron casting minus expansion of annealed casting) is normally 1/8 in. per ft. Therefore, the size tolerance is 1/16 in. per ft.

However, it should be remembered that shrinkage allowance, and therefore size tolerance, varies somewhat with composition, length and size of casting, and that intricate castings having flanges or projections usually require special allowances. Where extra high accuracy is required malleable castings can be die straightened or coin pressed. Because of high ductility, malleable iron readily lends itself to these sizing operations. If castings are straightened, one and usually not more than two dimensions can be held to 1/64 in. When coin pressing is employed, tolerances of ±0.007 to ±0.010 in. can be held.

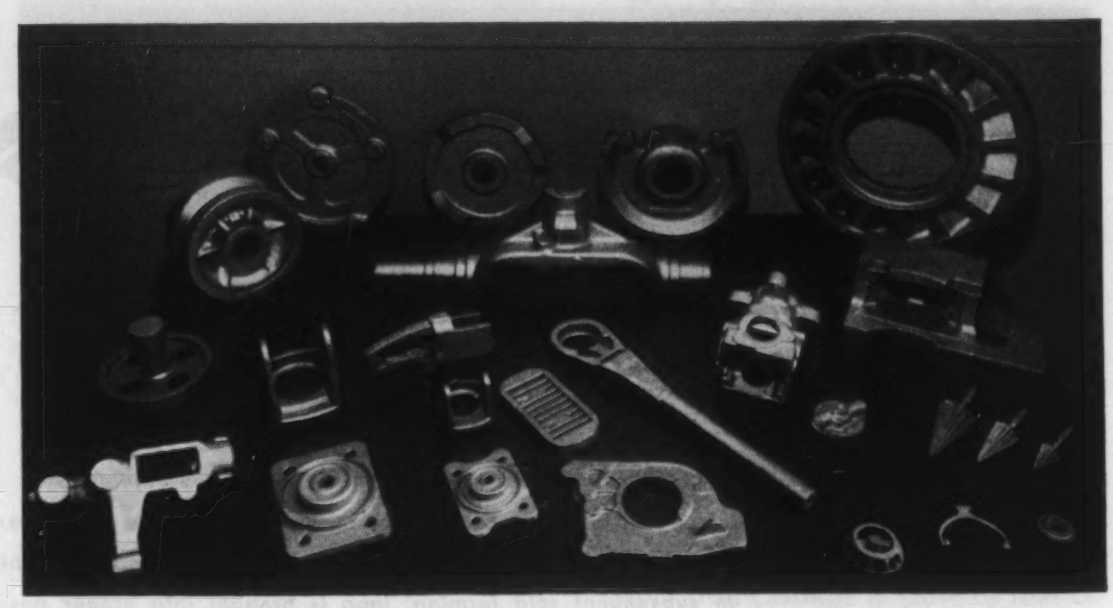
Because they have excellent machinability, malleable castings can be finished at relatively low cost to final dimensions by machining. The finish allowances for machining are as follows:

For milling: 1/16 to 3/32 in. for small castings; 1/8 to 3/16 in. for medium castings; and more for larger castings.

For reaming: 3/32 in. on the diameter for cored holes under 1 in.; 1/8 to 3/16 in. on the diameter for medium castings; and more for larger holes.

It is necessary with malleable castings, as with all castings, to allow for pattern draft. The standard practice in production castings is 1/64 in. per in. This is less than 1 deg, as compared to 7 deg required for forgings. For loose patterns with a deep draw, a draft of approximately 1/4 in. per ft is required.

As with all castings, some misalignment of surfaces may result in casting, because it is practically impossible for the top and bottom molds to align perfectly. Where it is necessary to avoid this slight misalignment, the critical surfaces should be located, if possible, in the same part of the mold. Surfaces approximately parallel to the parting plane of the molds will be the most accurate. Where cores are required, their location in the mold is also subject to some variation. With good design, accurate pattern equipment and controlled foundry practice, core shifts and fins are negligible.



Some typical parts made of pearlitic malleable iron. (Eastern Malleable Iron Co.)

Processing Characteristics

Casting Properties

Malleable irons have excellent casting properties. They possess good fluidity and their solidification rate is low enough to permit the free flow of molten metal to all parts of the casting. This makes possible production of uniformly sound castings by proper gating and feeding. It also makes malleable iron suitable for intricate or thin-sectioned castings.

The casting properties of standard grades and of pearlitic grades are the same because their compositions when cast are the same. Compared to other ferrous casting materials, malleable irons have better fluidity than steel, but are not as good as gray irons in this respect.

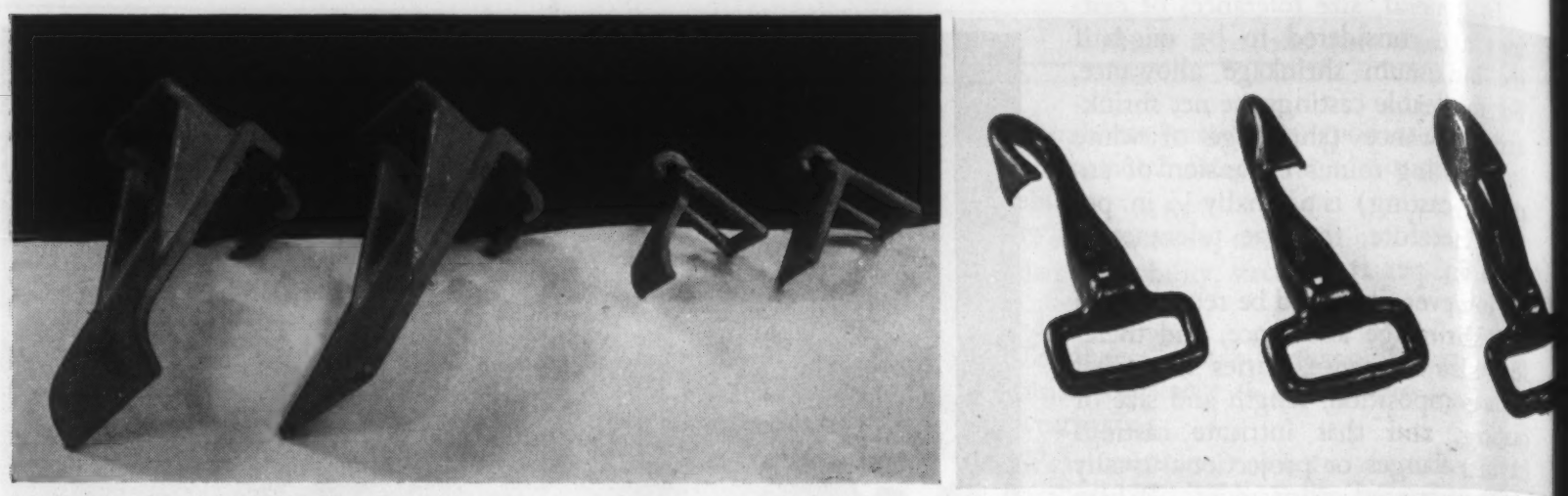
Strains produced by internal stresses, resulting from unequal contraction of the metal as a casting cools, are not present in finished malleable castings. Thus, there is no danger of warpage or distortion when the castings are subject to subsequent machining operations. Any casting strains that might be present in malleable iron castings are removed in the annealing cycle, which is an integral part of manufacturing the castings. This annealing treatment provides a homogeneous stress-free casting.

The engineer and designer can frequently help in achieving castings of optimum soundness and uniformity by adapting the design of the part as much as possible for good foundry practice. To do this, cooperation between the customer and producer is essential early in the design stages, and preferably before pattern design begins. The foundry should be informed of the exact type of service the casting will meet. It can then often suggest minor changes in design to help produce a sound casting. If service requirements dictate a design that might result in unsound sections, section thicknesses can often be increased or apportioned slightly differently to correct the condition.

Heat Treating

Standard and pearlitic malleable irons respond well to heat treatment. Although through-hardening is possible, malleable is more often either local or surface hardened, because if through-hardened, malleable iron loses some of its ductility, which is one of its most important attributes. By surface or local hardening, its ductility and shock resistance are retained while its surface hardness is markedly increased to provide better wear resistance and/or strength.

Pearlitic malleable iron is preferred over standard grades where surface hardening is to be done. The combined carbon present in pearlitic, but not in standard grades, permits rapid hardening. It has been found that a densely spheroidized carbide matrix responds best to localized hardening. In order to obtain a hardened case of at least 50 Rockwell C, it is advisable to have no less than 0.40% combined carbon in the ma-



Because of their ductility, malleable castings can be brought to final shape by a subsequent forming operation. Left: Conveyor links are cast straight and then put through forming dies, which curve them to desired shape. Right: Harness snap, as-cast, has loop at an angle; in subsequent cold forming, loop is brought into proper position as shown.

trix. Since slightly decarburized surfaces are sometimes encountered in malleable castings, best practice is to heat treat machined surfaces. Nevertheless, a great deal of pearlitic is hardened before machining.

To surface harden pearlitic malleable iron, it is heated to within the range 1500 F to 2100 F to redesolve the carbon in the ferrite matrix. It is then liquid quenched through the critical range to produce a martensitic structure. Oil or water can be used as the quenching medium. For complicated castings, oil is preferred because it provides shallow hardening, and gives less distortion and cracking. If the hardened surface requires some toughness, the casting can be tempered at about 600 F without losing much hardness. In general, a hardness of about 52 to 57 Rockwell C will be retained after tempering.

To surface harden standard grades, it is necessary to first put the temper carbon into solution by heating for a longer time in the range indicated above for pearlitic irons. After this, the casting is cooled rapidly through the critical temperature range to retain the carbon in combined form. Hardness of about 50 Rockwell C or higher can be obtained by this treatment.

Table 4—Machinability Values

	Machinability Rating, %	Brinell Hardness Number
Standard Malleable Iron	120	110-145
Pearlitic Malleable Iron	90	180-200
Pearlitic Malleable Iron	80	200-240
B1112 Steel	100	179-229
B1113 Steel	135	179-229
C1118 Steel	80	143-179
C1137 Steel	70	187-229
C1022 Steel	70	159-192
A4130 Steel	65	187-229
Cast Iron—Soft	80	160-193
Cast Iron—Medium	65	193-220
Cast Iron—Hard	50	220-240

Machinability

Excellent machinability is one of the main advantages of standard malleable irons. It is generally considered to be the most easily machinable and free cutting of any of the irons and steels of comparable or higher strength. This excellent machinability is attributed to its uniform structure and the presence of nodular temper carbon, which serves as a lubricant in machining operations.

Table 4 compares the machinability rating of standard and pearlitic malleable irons with other common ferrous materials. With AISI 1112 having a base rating of 100, standard malleable iron is rated highest at 120.

The machinability rating of malleable iron when measured in terms of the amount of energy required to remove a given amount of metal is also excellent. In one particular set of tests comparing malleable cast irons, cast steels and rolled steel, the malleable irons were rated on top.

Because of the combined carbon present in pearlitic malleable irons, they machine less easily than standard grades, as can be seen from Table 4. It has been found that 1% copper increases the machinability of pearlitic malleable to about 85% that of standard grades. In general, when compared to steel bar stock and drop forgings of the same hardness, pearlitic malleables can be machined in less time with greater tool life and at less cost. Since there are a number of pearlitic malleables available with different hardnesses and structures, it is possible to choose one which has a machinability close to the desired one for most applications.

Cold Working

Because of its high toughness and ductility, malleable iron castings can be cold formed to improve the shape and dimensional accuracy.

Straightening is commonly performed on malleable castings after the annealing cycle. Thin section castings of simple design are often straightened manually with a hammer. Heavier section castings, or those of more intricate shape, are straightened in dies under hydraulic presses.

Malleable iron will withstand considerable bending before cracking, as is evident from the "curl" test described earlier. Therefore, if in service a malleable casting becomes distorted, it can often be restored to service by cold straightening.

Coining or coin pressing of standard malleable irons is increasing as a means of producing castings to close tolerances. Castings can be coined to size tolerances of ± 0.010 in. Surfaces to be coined should involve as small an area as possible, and depressed surfaces or recesses should be provided to accommodate the metal displaced.

Within limits, malleable irons can also be sheared, punched and rolled.

Joining

Fusion welds in standard and pearlitic malleable irons are brittle and, therefore, are not recommended where stressed parts are involved. However, where tensile stresses are low or compressive, fusion welding can sometimes be successfully employed. Small defects in castings can be repaired by welding if care is taken so that the welding heat does not penetrate into stressed sections, unless the casting is re-annealed after welding.

Brazing and soldering can be done on malleable iron using filler metals that flow under 1350 F. Silver brazing alloys with the proper fluxes are commonly used.

The usual method of joining malleable castings to each other or other parts is by fasteners such as bolts, screws and rivets. To obtain strong, shock and fatigue proof joints the fastener must be pulled up tight to approximately the yield point of the fastener.

The good ductility of malleable iron permits certain assemblies to be joined by peening, crimping or spinning. Riveting or crimping lugs, bosses or flanges can often be designed into the casting. Cast flanges and edges may be crimped or upset to retain inserts or inserted assemblies.

Finishes and Coatings

Besides the usual finishing operations of tumbling or blasting, standard and pearlitic malleable iron castings can be further finished to meet specific service requirements. Thus, castings can be plated, tinned, galvanized or painted. When any of these finishes are to be applied, the castings in some cases require special cleaning treatment.

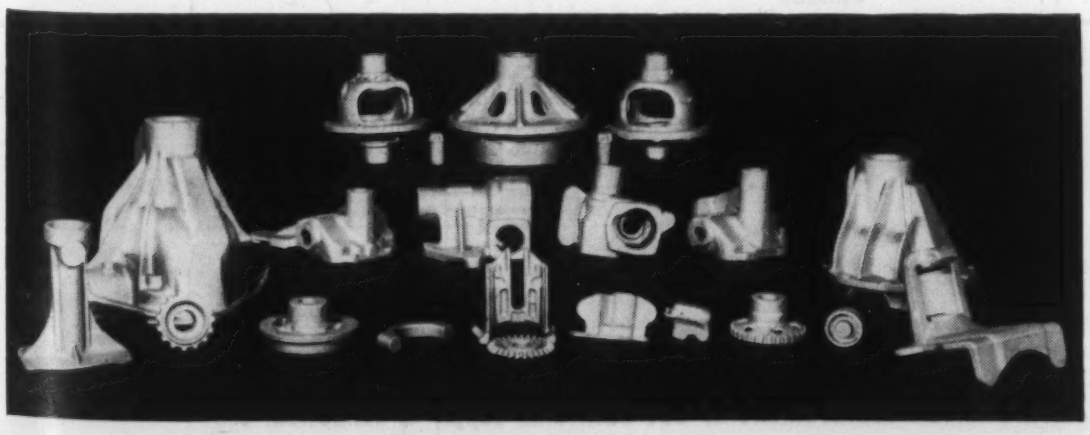
Malleable iron castings used in mechanical axle jacks. (Auto Specialties Manufacturing Co.)

The most common metals plated on malleable castings are zinc, aluminum lead and cadmium. Where superior appearance is required, chromium, nickel and silver can be used.

Zinc coating by the hot-dip galvanizing process is the most widely used method of coating malleable irons. To avoid the possibility of embrittlement, castings that are to be galvanized are usually quenched from 1200 F, or a small amount of phosphorus is added to the composition.

Two types of chemical conversion treatments can be applied to malleable castings prior to coating with organic finishes: a thick iron oxide coating which is brittle and, therefore, not suitable for castings subject to bending or twisting; an iron phosphate coating which is more flexible but may occasionally have pinholes.

Almost any type of rust resisting paint, enamel or lacquer can be applied to castings with or without one of the above oxide coatings. However, a more durable finish results when an oxide coating is present under the organic finish.



Typical malleable castings produced for automotive passenger car, truck and tractor applications. (Auto Specialties Manufacturing Co.)

Cost Considerations

To discuss costs in general terms is always dangerous. The fluctuations in market price of materials is only one relatively minor variable compared to many and important variables involved in the engineering and production of a casting. Therefore, in the following brief discussion of costs it must be understood that there are always exceptions to general rules, and that for accurate cost comparisons each case must be considered individually.

In general, then, the cost of malleable iron castings is close to that of forgings. On short runs or jobbing work, malleable costs less than forgings, whereas on longer runs, the costs are very close. In both long and short runs the machining costs are less with malleable iron. A casting can be made to closer machine dimensions which results in less machining time and in less stock being removed. Also, longer tool life is obtained when machining malleable. In parts requiring holes or cavities it is usually less costly to core and ream them than to machine or drill them out of solid stock.

Unfinished gray iron castings are normally lower in cost than malleable castings. Because of higher strength, malleable castings may, depending on the application, permit thinner section thicknesses, which would lower costs in comparison to gray iron. Also, where machining is required, machining costs would be less with malleable.

Both nodular iron and steel castings are higher in cost on a pound basis than malleable iron castings. Nodular iron, like malleable, has good machinability, while steel castings cost considerably more to machine. However, steel castings being of higher strength may permit thinner sections, and thus may offset high machining costs.

References

"American Malleable Iron—A Handbook", Malleable Founders' Society.
"Cast Metals Handbook", American Foundrymen's Assn.
"Metals Handbook", American Society for Metals.

Acknowledgments

We gratefully acknowledge the splendid help and cooperation given us by the Malleable Founders' Society and by the malleable iron casting industry in supplying information for this Manual.

Frontispiece courtesy Malleable Founders' Society (top) and Frazer & Jones Co., Div. Eastern Malleable Iron Co. (bottom).

(*See next page for Directory*)

Directory of Producers of Malleable Iron Castings

California

General Metals Corp., Los Angeles 54

Connecticut

Connecticut Malleable Castings Co., New Haven 6
Eastern Malleable Iron Co., Naugatuck
Malleable Iron Fittings Co., Branford
New Haven Malleable Iron Co., New Haven 4

Delaware

Eastern Malleable Iron Co., Wilmington 99

Illinois

Central Foundry Div., General Motors Corp., Danville
Chicago Malleable Castings Co., Chicago 43
Chicago Railway Equipment Co.:
General Offices—Chicago 9
Plant (Marion Malleable Iron Works—Marion, Ind.)
John Deere & Co., Moline
Gunite Foundries Corp., Rockford
Moline Iron Works, Moline
Moline Malleable Iron Co., St. Charles
National Malleable & Steel Castings Co., Cicero 50
Nye Tool Co.:
General Offices—Chicago 39
Plant—Galesburg
Peoria Malleable Castings Co., Peoria
Wm. E. Pratt Mfg. Co., Joliet
Wagner Malleable Iron Co., Decatur 2

Indiana

The Dalton Foundries, Inc., Warsaw
Link-Belt Co., Indianapolis 6
Muncie Malleable Foundry Co., Muncie
National Malleable & Steel Castings Co., Indianapolis 6
Richmond Malleable Castings Co., Richmond
Terre Haute Malleable & Mfg. Corp., Terre Haute

Iowa

Iowa Malleable Iron Co., Fairfield

Massachusetts

Arcade Malleable Iron Co., Worcester 4
Belcher Malleable Iron Co., Easton

Michigan

Albion Malleable Iron Co., Albion
Auto Specialties Mfg. Co., St. Joseph
Benton Harbor Malleable Industries, Benton Harbor
Cadillac Malleable Iron Co., Cadillac
Central Foundry Div., General Motors Corp., Saginaw
Michigan Malleable Iron Co., Detroit 17
Superior Steel & Malleable Castings Co., Benton Harbor

Minnesota

Northern Malleable Iron Co., St. Paul 6

Missouri

St. Louis Malleable Casting Co., St. Louis 15

New Hampshire

Laconia Malleable Iron Co., Laconia

New Jersey

Meeker Foundry Co., Newark 4
Newark Malleable Iron Works, Newark 5

New York

Acme Steel & Malleable Iron Works, Buffalo 7
Albany Castings Co., Inc., Voorhesville
Frazer & Jones Co., Solvay
Jamestown Malleable Co., Inc., Buffalo 7
Kencroft Malleable Co., Inc., Buffalo 7
Lancaster Malleables & Steel Corp., Lancaster
Oriskany Malleable Iron Co., Inc., Oriskany
Westmoreland Malleable Iron Co., Westmoreland

Ohio

American Malleable Castings Co., Marion
Canton Malleable Iron Co., Canton 5
Columbus Malleable Iron Co., Columbus 3
Dayton Malleable Iron Co., Dayton 1
Dayton Malleable Iron Co., Ironton
Eberhard Mfg. Co., Cleveland 4
Haven Malleable Castings Co., Cincinnati 23
I. F. Sales Co., New Philadelphia
Lake City Malleable Co., Cleveland 14
Lake City Malleable Inc., Ashtabula
Maumee Malleable Castings Co., Toledo 5
National Malleable & Steel Castings Co., Cleveland 6
Ohio Malleable Iron Co., Columbus 16
Webster Mfg., Inc., Tiffin

Pennsylvania

American Chain & Cable Co., Inc., York
Carbon Malleable Casting Co., Lancaster
Columbia Malleable Castings Corp., Columbia
Erie Malleable Iron Co., Erie
Fort Pitt Malleable Iron Div. of Steel Trading Corp., Pittsburgh 30
General Electric Co., Erie
Lancaster Malleable Castings Co., Lancaster
Lehigh Foundries, Inc., Easton
Meadville Malleable Iron Co., Meadville

Rhode Island

New England Malleable Iron Co., Lincoln Park 7

Texas

Texas Foundries, Inc., Lufkin

West Virginia

West Virginia Malleable Iron Co., Point Pleasant

Wisconsin

Badger Malleable & Mfg. Co., South Milwaukee
Belle City Malleable Iron Co., Racine
Chain Belt Co., Milwaukee 4
Federal Malleable Co., West Allis
General Malleable Corp., Waukesha
International Harvester Co., Milwaukee
Kirsh Foundry, Inc., Beaver Dam
Lakeside Malleable Castings Co., Racine
Malleable Iron Range Co., Beaver Dam
Milwaukee Malleable & Grey Iron Works, Milwaukee 7

Canada

Auto Specialties Mfg. Co (Canada) Ltd., Windsor, Ontario
Bowmanville Foundry Co., Ltd., Bowmanville, Ontario
Canadian Car & Foundry Co., Ltd., Brantford, Ontario
Fittings Limited, Oshawa, Ontario
Galt Malleable Iron Co., Ltd., Galt, Ontario
International Malleable Iron Co., Ltd., Guelph, Ontario
Ontario Malleable Iron Co., Ltd., Oshawa, Ontario

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Materials Engineering File Facts

MATERIALS & METHODS
March • 1953
Number 246

Materials Data Sheet

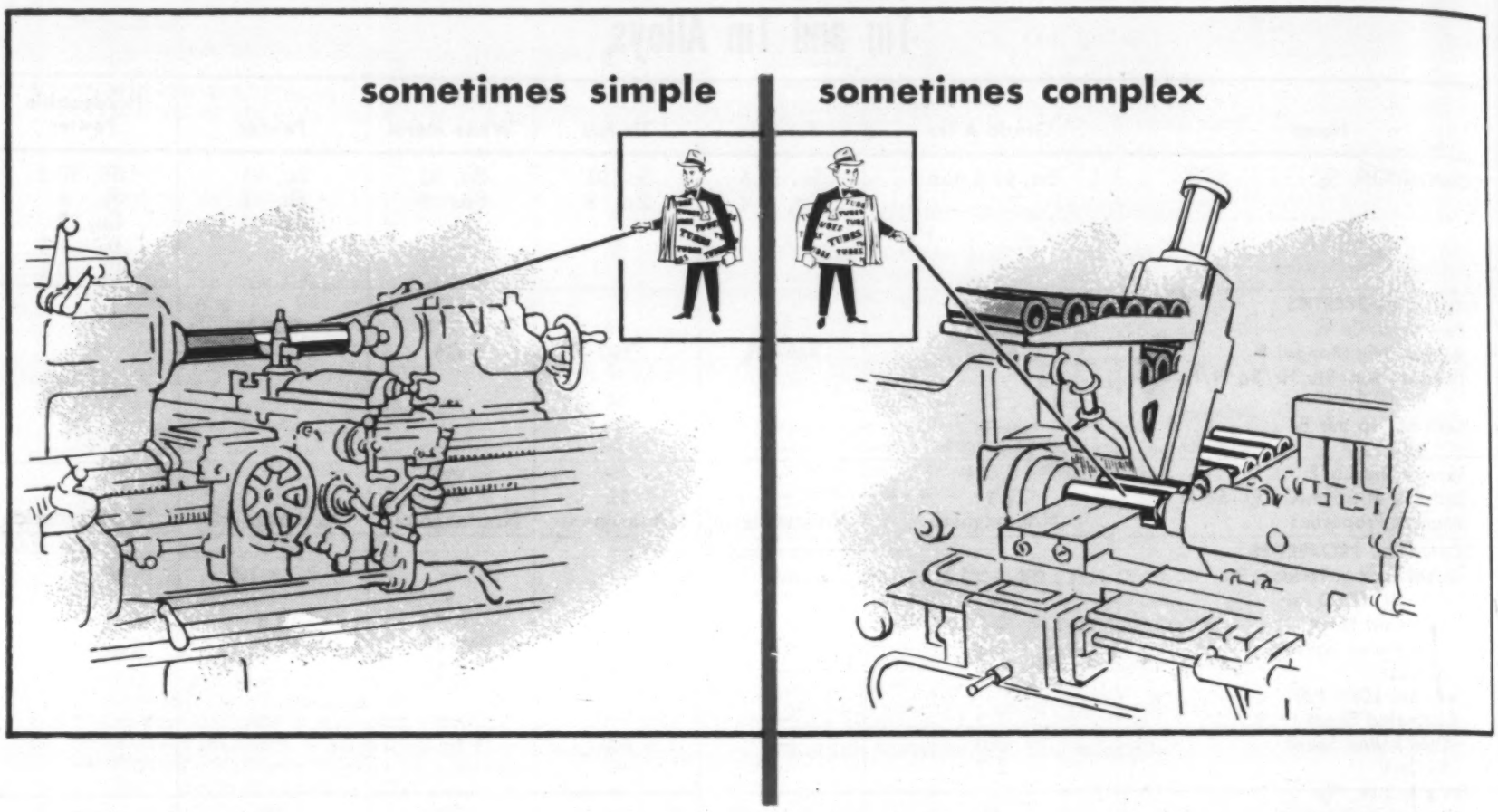
Tin and Tin Alloys

Name	Grade A Tin	Hard Tin	Tin Foil	White Metal	Pewter	Hardenable Pewter
COMPOSITION, %	Sn, 99.8 min	Sn, 99.6 Cu, 0.4	Sn, 92 Zn, 8	Sn, 92 Sb, 8	Sn, 91 Sb, 7 Cu, 2	Sn, 90.5 Sb, 6 Cu, 2 Bi, 1.5 P, 0.1
PHYSICAL PROPERTIES						
Density, Lb/Cu In.	0.264	—	—	0.262	0.263	—
Melting Point (Range) F	449.4	446-441	390	475	563-471	—
Thermal Cond, Btu/Hr/Sq Ft/Ft/F, @ 77 F	37	—	34	—	—	—
Coeff of Exp per F:						
32-212 F	13×10^{-6}	—	—	—	—	—
Spec Ht, Btu/Lb/F:	0.054	—	—	—	—	—
Elect Res, Microhm-Cm @ 68 F:	11.5	—	12	15	—	—
Magnetic Properties	Nonmagnetic	Nonmagnetic	Nonmagnetic	Nonmagnetic	Nonmagnetic	Nonmagnetic
MECHANICAL PROPERTIES						
Mod of Elast in Tension, Psi	$6\text{-}6.5 \times 10^6$	—	—	—	7.7×10^6	—
Tensile Str, 1000 Psi:						
Annealed Sheet	2.2	3.3	—	6.7	8.6	—
Cold Rolled Sheet	2.8	4.0	8.7	7.4[2]	7.6	—
As Cast	2.1	—	—	7.2[3]	—	—
Yield Str, 1000 Psi:						
Annealed Sheet	1.3	—	—	—	—	—
Cold Rolled Sheet	2.0	—	6.0	—	—	—
As Cast	1.7	—	—	—	—	—
Elong in 2 In., %:						
Annealed Sheet	45	—	—	70	40	—
Cold Rolled Sheet	35	—	40	28[2]	50	—
As Cast	55[1]	—	—	—	—	—
Hardness Bhn:						
Annealed Sheet	7	—	—	17	13[4]	13[4]
Cold Rolled Sheet	8	—	—	—	18[5]	28[5]
As Cast	5-6	—	—	20[3]	23[4]	29[4]
Impact Strength, Izod, Ft-Lb:						
As Cast	14	—	—	22[3]	—	—
Fatigue Strength (End. Limit), 1000 Psi:						
As Cast	0.34	—	—	—	—	—
FABRICATING PROPERTIES						
Casting Temp, Range F:						
Chill	525-550	525-550	—	575-600	600-625	600-625
Joining	Bonds easily by simple melting. Eutectic tin-lead solder or low melting fusible alloys might be used on massive parts such as block tin pipe.	Similar to Grade A.	—	Readily soldered.	Can be soldered with some of the fusible alloys.	Can be soldered with some of the fusible alloys.
CORROSION RESISTANCE	Resistant to distilled water, sea water, and soft tap water. Slightly attacked by hard tap water. Attacked by strong acids, alkalies and acid salts. Oxygen in solution accelerates rate of attack.	Similar to Grade A.	—	—	Tarnishes in soft water, localized attack at water line in hard water. Attacked by dilute hydrochloric and citric acids in presence of air.	Tarnishes in soft water, localized attack at water line in hard water. Attacked by dilute hydrochloric and citric acids in presence of air.
AVAILABLE FORMS	Sheet, pipe, foil, castings, powder.	Tubing, foil.	Foil.	Castings, sheet.	Castings, sheet.	Castings, sheet.
USES	Linings for food cans; pipe for handling water, beer, carbonated beverages; lining of equipment for food industries; wrappings for food.	Collapsible tubes, foil.	Foil for wrapping of food products, medicines, electrical condensers.	Rubber mold castings, cast and wrought costume jewelry.	Mountings and ornamental objects such as tea and coffee services, vases, bookends, etc.	Mountings and ornamental objects such as tea and coffee services, vases, bookends, etc.

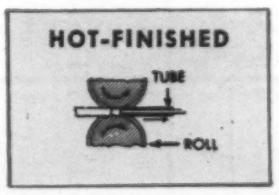
NOTES: *1—In 4 in.*
2—Sheet quenched from 425 F.
3—Chill cast.
4—Vickers Pyramid Hardness.
5—Vickers Pyramid Hardness after heat treating 3 hr at 300 F.

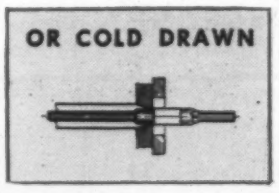
Prepared with the assistance of the Tin Research Institute, Inc.

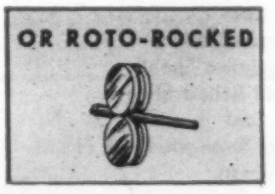
Machinability of Tubing



requiring . . .





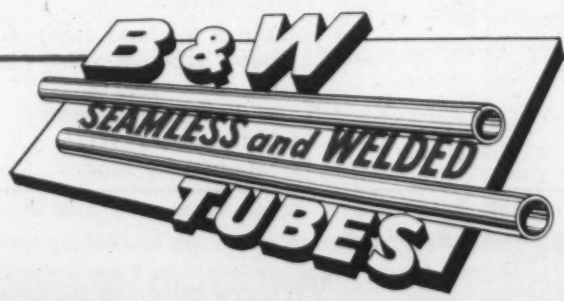


Much can be said about the comparative machinability of these three types of seamless mechanical tubing. What is best for one user is not always best for another user. For example —B&W is supplying mechanical tubing to three different manufacturers who are producing the same piece of equipment — one from Hot-Finished tubing, the second from Cold-Drawn tubing, and the third from Roto-Rocked tubing. The real criterion for machinability rests with the user and how he is equipped to produce the part.

In determining the type to be used in a specific application attention should also be given to the differences in surface finish, tolerances, and original cost which exist between hot-finished and cold-finished tubing and how these factors affect final production costs.

Mr. Tubes—your nearby B&W Tubing Representative — is a good man to consult when you want to match tubing types to your plant facilities and specific jobs . . . to keep production up and costs down. You'll find B&W Bulletin TB-340, "A Guide to the Use of Seamless Mechanical Tubing", helpful, too. Write for it.

THE BABCOCK & WILCOX COMPANY
TUBULAR PRODUCTS DIVISION
Beaver Falls, Pa.—Seamless Tubing; Welded Stainless Steel Tubing
Alliance, Ohio—Welded Carbon Steel Tubing



TA-1718(M)

Materials Engineering File Facts

MATERIALS & METHODS
March • 1953
Number 247

Materials Data Sheet

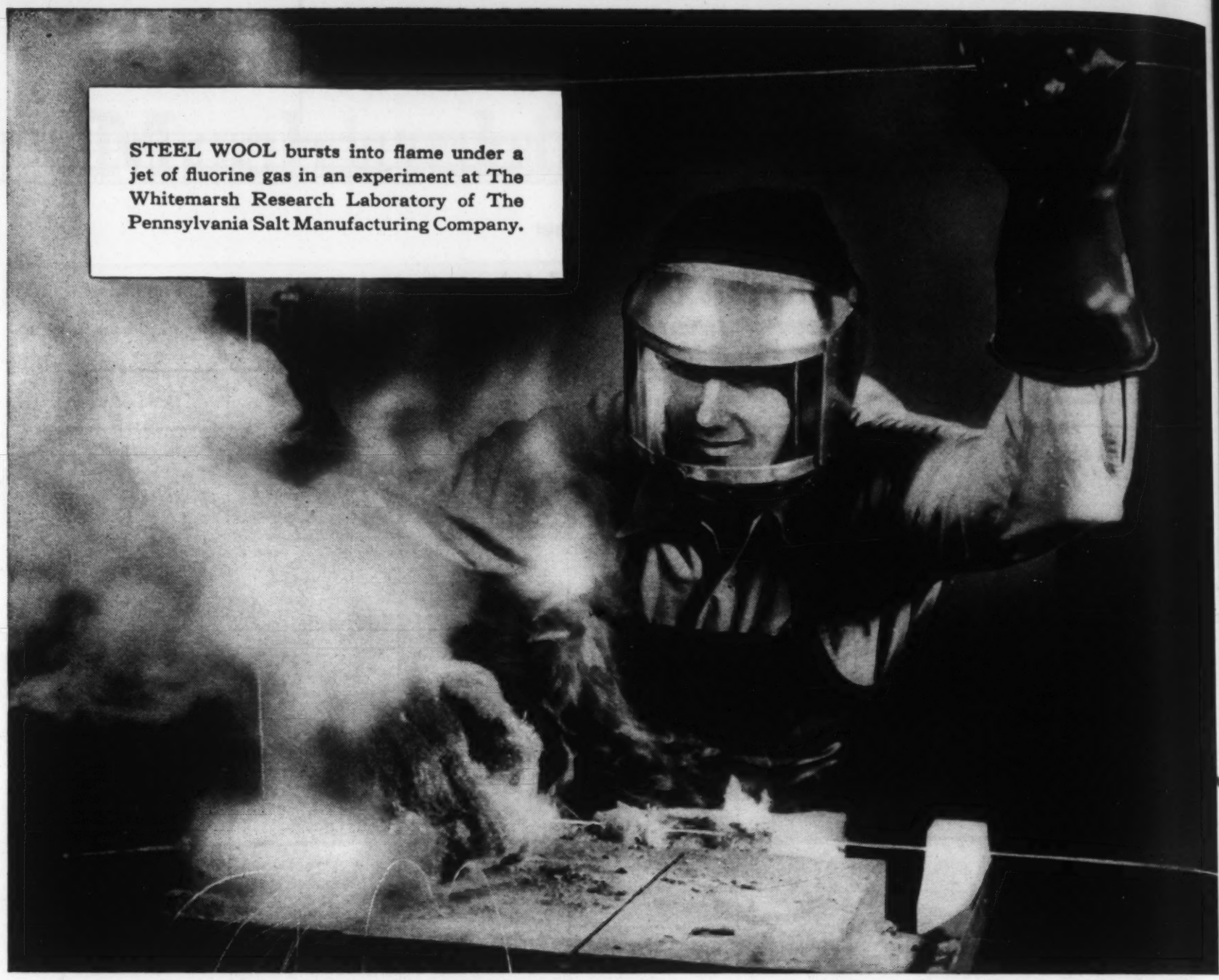
Tin-Base Bearing Metals

Compared with some other bearing materials, the tin-base bearing alloys have relatively low resistance to fatigue but their resistance is sufficient to warrant their use in low load applications. They are easy to bond and handle on a production basis and have excellent anti-seizure properties.

ASTM Spec B23-49	Grade 1[1]	Grade 2	Grade 3	Grade 4	Grade 5[2]
COMPOSITION, %	Sn, 91 Sb, 4.5 Cu, 4.5	Sn, 89 Sb, 7.5 Cu, 3.5	Sn, 84 Sb, 8 Cu, 8	Sn, 75 Pb, 10 Sb, 12 Cu, 3	Sn, 65 Pb, 18 Sb, 15 Cu, 2
PHYSICAL PROPERTIES					
Density, Lb/Cu In.	0.265	0.267	0.269	0.272	0.280
Melting Range, F	433-700	466-669	464-792	363-583	358-565
MECHANICAL PROPERTIES					
Mod of Elast in Tension, Psi	7.3×10^6	7.6×10^6	—	—	—
Tensile Str, 1000 Psi:					
Chill Cast	9.3	11	10-12	—	—
Die Cast	10.3	—	—	—	11.8
Elong in 2 In., %					
Die Cast	22	—	—	—	4
Hardness Bhn:					
Chill Cast	17	24	27	25	22
Die Cast	—	—	—	—	27.7
Impact Strength, Izod, Ft-Lb:					
Chill Cast	2.5	—	1	—	—
Fatigue Strength (End. Limit), 1000 Psi:					
Chill Cast	3.8 (2×10^7 cycles)	4.8 (2×10^7 cycles)	—	—	—
Compressive Yield Str, 1000 Psi:					
Chill Cast (0.125% Set)	4.4	6.1	6.6	5.5	5.0
Compressive Str, 1000 Psi:					
Chill Cast (25% Set)	13	15	18	16	15
FABRICATING PROPERTIES					
Casting Temp, Range F:					
Chill	750-825	795	850-915	710	690-700
CORROSION RESISTANCE	Resistant to oxidation products of lubricants, food products, beer, carbonated beverages.	Resistant to oxidation products of lubricants.	Resistant to oxidation products of lubricants.	Resistant to oxidation products of lubricants.	Resistant to oxidation products of lubricants.
AVAILABLE FORMS	Precision inserts of babbitt-lined strip, lined bearing shells, ingots.	Precision inserts of babbitt-lined strip, lined bearing shells, ingots.	Precision inserts of babbitt-lined strip, lined bearing shells, ingots.	Ingots.	Ingots.
USES	Bearings; die castings for dairy machinery, dental appliances, surgical instruments, soda fountain equipment.	Most widely used tin-base bearing alloy in automotive field.	Hardest of standard tin babbits and has greatest load carrying capacity.	Limited bearing applications.	Limited bearing applications: die cast parts.

NOTES: [1] *Also die casting alloys, spec B102-48, Alloy 1.*
[2] *Also die casting alloys, spec B102-48, Alloy 3.*

Prepared with the assistance of the Tin Research Institute, Inc.



STEEL WOOL bursts into flame under a jet of fluorine gas in an experiment at The Whitemarsh Research Laboratory of The Pennsylvania Salt Manufacturing Company.

When Metal Bursts into Flame

Imagine, if you can, an element so fierce it burns up steel. One that claws its way through fire-brick . . . makes water burn like alcohol . . . destroys almost everything it touches.

That's fluorine for you!

And for over two hundred years chemists racked their brains to find some material that would hold fluorine. Hold it for even a few minutes' study.

Numerous materials — all considered dependably resistant to corrosion — were tried. Most went up in a flash.

Some few seemed to work, momentarily. But let temperature rise a trifle, or pressure build up . . . or a trace of moisture seep in . . . then dig out the wreckage and start over.

Finally Nickel and its alloys were tried. They work. They last for months where other materials failed in days or weeks.

Today, you find Nickel and Inco Nickel Alloys in equipment that produces fluorine . . . in pumps and piping and valves where fluorine is compressed, stored, and processed. Nickel and Inco Nickel Alloys hold fluorine, even under heat and pressure. By the way, if you would like to know more about fluorine, ask us for a copy of "Fluorine Makes Its Debut."

When you have a metal problem
If it's corrosion, it can't be any tougher than that caused by fluorine . . . and the solution may be found in Inco Nickel or one of the Inco Nickel Alloys.

Inco corrosion engineers are ready to help you. They've prepared a Corrosion Data Work Sheet to make it easy for you to outline your problem to them. Write for it, without obligation, of course.

• • •

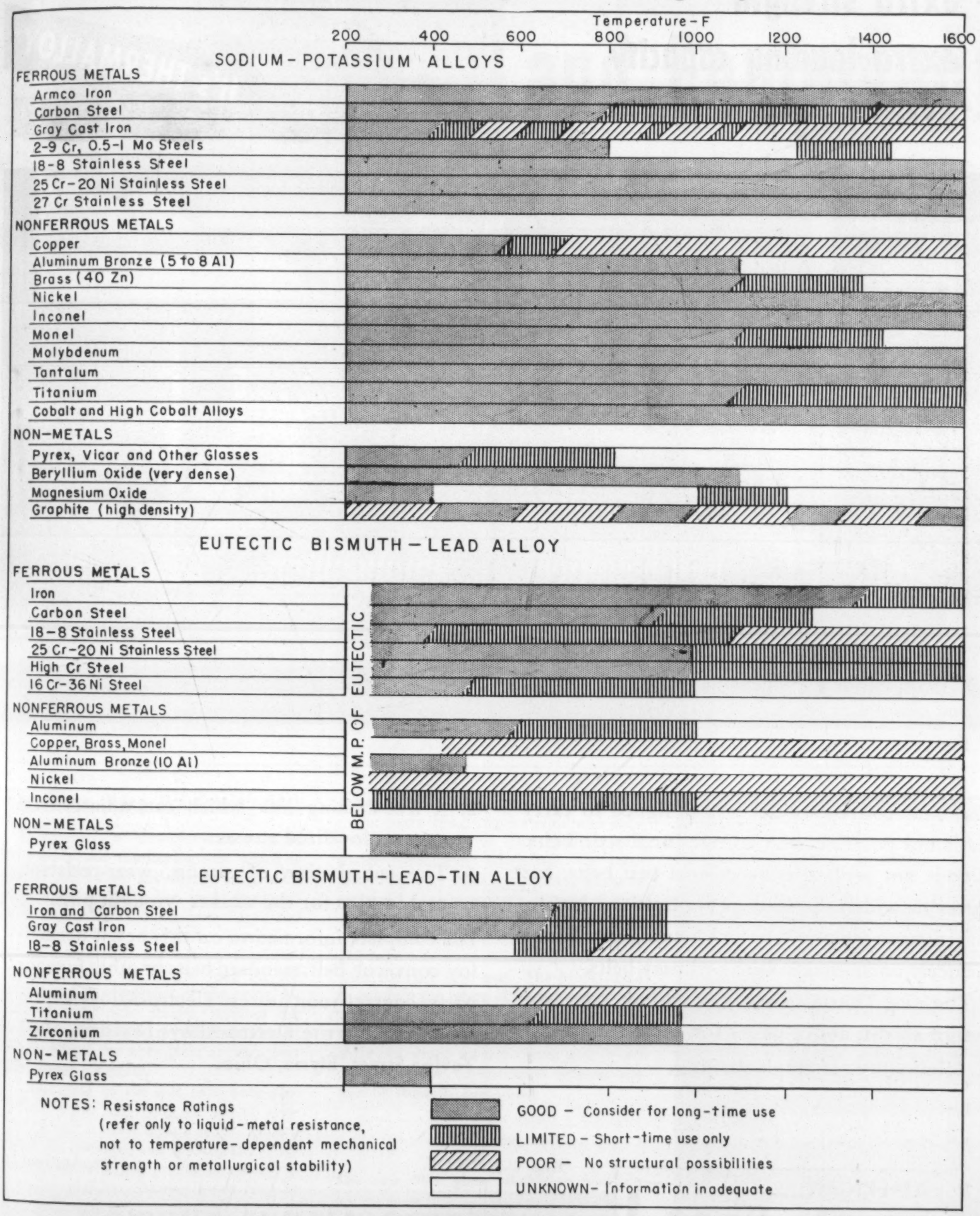
Or perhaps your metal problem concerns temperatures—high or low . . . stresses or fatigue resistance. Whatever it may be, Inco engineers will gladly help you find the answer. The International Nickel Company, Inc., 67 Wall St., New York 5, N. Y.

Inco Nickel Alloys

INCO TRADE MARK

Monel® • "R"® Monel • "K"® Monel
"KR"® Monel • "S"® Monel • Nickel
Low Carbon Nickel • Duranickel® • Inconel®
Inconel "X"® • Incoloy® • Nimonics®

Corrosion of Materials by Liquid Low Melting Alloys

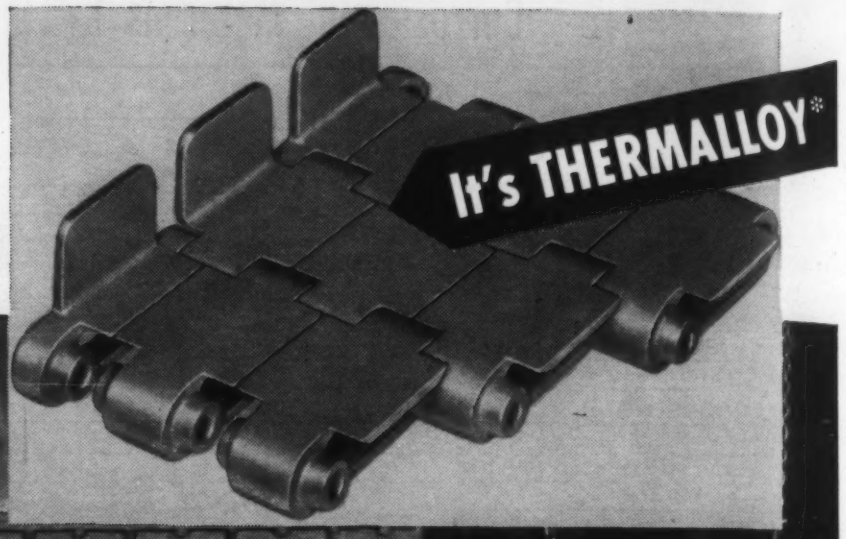


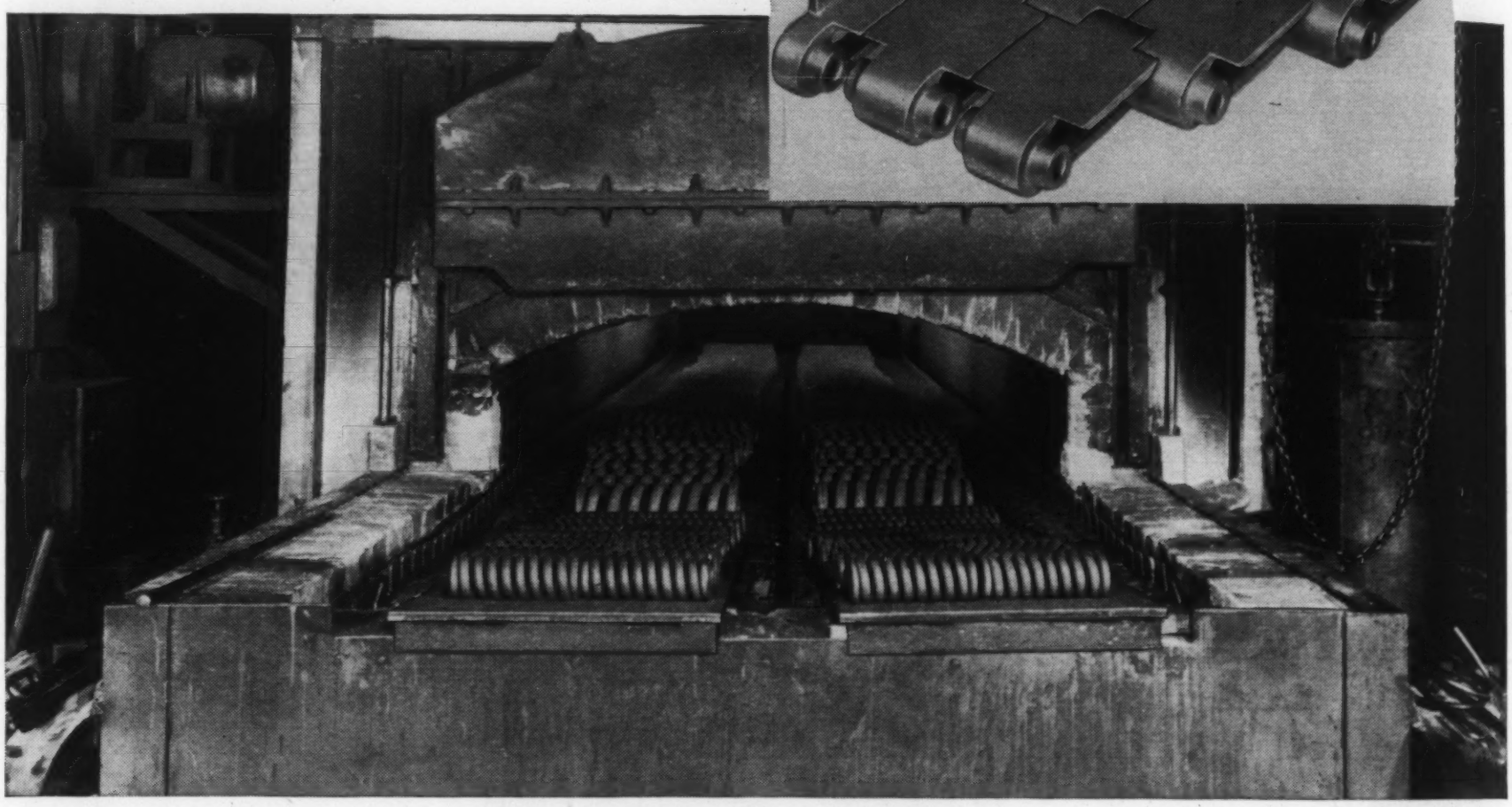
Adapted from Liquid Metals Handbook

NEW CONVEYOR DESIGN

offers extra heat-treat advantages . . .

- *extra* strength
- *extra* loading capacity
- *extra* long service





This new conveyor belt† was designed to carry loads not possible with conventional style belts. It does not replace conventional cast belts, but serves to widen the field to applications involving extreme temperature and loading conditions formerly unattainable with ordinary belts.

The new Thermalloy staggered-link, conveyor design shown above offers you these features:

1. Elimination of crank-shafting.
2. A free-floating link which can adjust itself to meet localized stresses.
3. The substitution of strong, wear-resistant, cast-in pins for the weaker wrought pins.

For complete information on this new Thermalloy conveyor belt, standard belts or other furnace parts, contact your nearest Electro-Alloys representative. Or write Electro-Alloys Division, 4001 Taylor Street, Elyria, Ohio.

*Reg. U.S. Pat Off. †Pat. Applied For

AMERICAN Brake Shoe COMPANY

ELECTRO-ALLOYS DIVISION
ELYRIA, OHIO

New Materials and Equipment

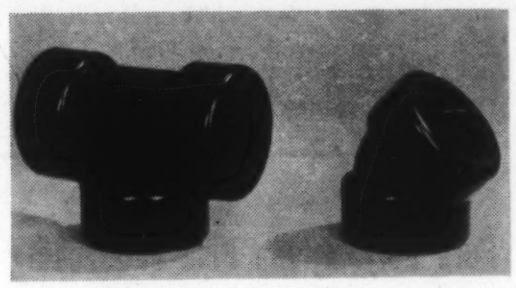
Heat Resistant Hard Rubber Available for Many Applications

Ace Tempron, a new synthetic hard rubber compound, is now said to make possible even greater chemical resistance, strength and economy of hard rubber available for sustained high temperature applications in handling many corrosive solutions. The material was developed by *American Hard Rubber Co.*, 93 Worth St., New York, N. Y.

Based on nitrile synthetic rubber (Buna-N), Tempron is a hard rubber which is claimed to have greater rigidity, heat resistance and chemical resistance than the hard and soft nitrile rubber compounds previously available. At present, the material is offered in four forms: (1) Pipe and fittings; (2) molded parts, with limitless design possibilities; (3) sheet, rod and tubes from which a wide variety of shapes can be machined or fabricated; and (4) a hand-fabricating process for making tanks, large fittings, etc., by forming sheets of Tempron around cores or mandrels while still in the soft state prior to vulcanization.

In chemical resistance at elevated temperatures, the rubber generally excels other rubber and plastic materials. At room temperatures, it resists nearly as many inorganic corrosives as natural hard rubber, and in addition, it is resistant to many organic chemicals which attack natural hard rubber, soft rubber and plastics. For instance, at room temperature it resists aliphatic hydrocarbons such as hexane, hexene, and other solvents such as ether, benzene, carbon tetrachloride, ethyl acetate and benzaldehyde. It is resistant to oils. It is not recommended for sodium hypochlorite or for strong oxidizing agents such as nitric acid.

Tempron is not just one formula, but a group of compounds which can be altered in many different ways to give just the right combination of physical, chemical and electrical properties for each specific application. It is a thermosetting material that is compression molded by the company in the same types of molds, using the same vulcanization techniques as for hard rubber. Inserts can either be molded in, or inserted after molding. Its machinability is said to be good, although carbide tools are recommended for good tool life. Polished molds, or polishing operations after machining, give Tempron a smooth, glossy surface.



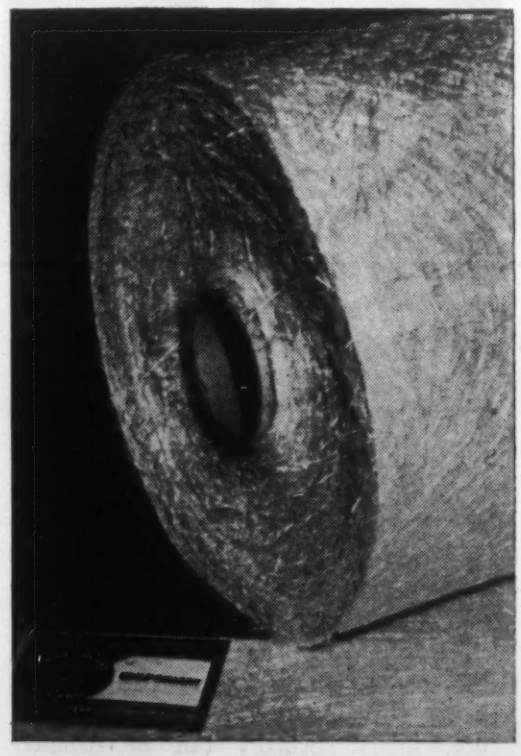
These parts are of a new heat resistant hard rubber compound said to have good chemical resistance and high strength.

New Fiber Glass Reinforcing Mat

Uniformat, a new-type fiber glass chopped strand reinforcing mat which is almost pure white and highly uniform in weight and pattern, has been developed by the *Fiber Glass Div., Ferro Corp.*, 200 Woodycrest Ave., Nashville, Tenn. Designed specifically for plastic reinforcement, the new mat can be used for the reinforcement of plastics of any color, including very light shades, without the occurrence of stains or discolorations at points where the fiber glass appears near the product's surface.

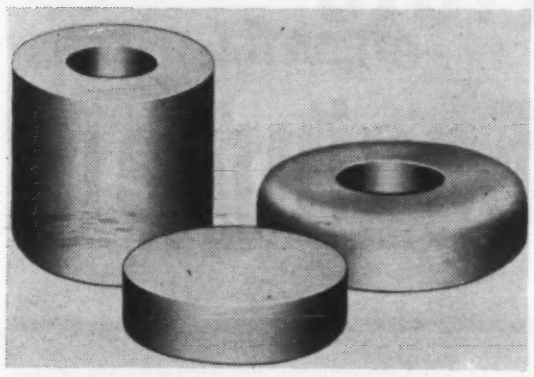
Two types of the mat have been produced: Ferro GP chopped strand reinforcing mat is made especially for matched metal die molding and is designed to resist the washing and tearing pressures exerted by molding action. It can also be used in periodic or continuous dip impregnation systems where retention of mat integrity during and after impregnation is required.

For parts which require rapid and complete wetting of the fiber glass strands under atmospheric conditions, the company offers its HSB mat, which is made especially for atmospheric cure work produced by bag molding, tailoring or hand lay up methods. Extremely low pressure and bake cure parts can also be reinforced with the HSB type mat. The binder used to produce the white HSB mat is partially soluble in the styrene component of polyester resins. This solubility gives the mat ability to drape around curves and to accept reasonable configuration without any loss of strength continuity.



This new fiber glass reinforcing mat can be used for the reinforcement of plastics of any color without the occurrence of discolorations.

New Materials and Equipment continued



These parts have been fabricated from a new tungsten alloy which resists radioactive ray penetration.

Tungsten Alloy Resists Radioactive Ray Penetration

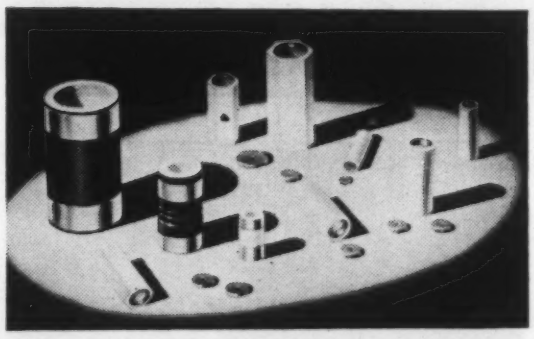
Metal Carbides Corp., 107 E. Indianola Ave., Youngstown, Ohio, is currently marketing a new noncutting metal of extremely high density. Comprised chiefly of tungsten, it has a specific gravity in excess of 17.5 GMS/CC, which is about 50% greater than lead. The new metal is being used very successfully, according to the company, to resist the penetration of radioactive rays, and its use for atomic radiation screening is increasing rapidly. In addition, the alloy is finding wide application as a metal suitable for static and dynamic balancing, as well as other applications requiring maximum weight and minimum space. Among applications in active use today is the use of this metal for balance weights on crank shafts, gyroscopes, propellers and centrifugal clutches.

The metal can be readily machined with carbide-tipped tools and can be produced in sizes up to 25 in. O.D. by 40 in. long and in weights that are in excess of 1000 lb.

Pure Polyethylene Pipe and Tubing

American Agile Corp., P. O. Box 168, Bedford, Ohio, has announced the availability of a wide range of pure, unpigmented polyethylene pipe and tubing, called Agilene CP. One-, 1½- and 2-in. N.P.S. dia pipe are now furnished in straight 2-ft lengths for easy installation. Tubing is available from ¼-in. O.D. to 30-in I.D., with the ¼- through 1-in. dia sizes being furnished in coils, while larger tubing is furnished in multiples of individual 4-ft sections joined by hot gas welding. The wall thickness in large diameter tubing can be supplied according to customer's requirements.

Due to the absence of any foreign matter in Agilene CP tubing and pipe, all the inherent excellent chemical and electrical properties of polyethylene are said to be retained, assuring continuous uniformity and complete freedom from contamination due to impurities. Also of interest to users will be the translucency of such tubing and piping, which thus permits the easy observation of liquid levels and the general flow conditions in the pipe.



These new sizes and types of metallized ceramic cases and end seals are for hermetic sealing of resistors, capacitors, etc.

New Sizes and Types of Metallized Ceramic Cases and End Seals

A number of new sizes, styles and types of AlSiMag metallized ceramic cases with or without metallized ceramic end seals are currently being shown by *American Lava Corp.*, Chattanooga 5, Tenn. These are widely used for hermetic sealing of resistors, capacitors, chokes and other components. The end seals fit accurately against metallized areas of the case. Soft soldering forms a trouble-free hermetic seal quickly and easily.

Most requirements for cases and seals can be met with one of the many AlSiMag sizes now in constant production. Special sizes, styles and types are made to meet specific requirements. They can be economically produced in small or large quantities.

Fast Curing Adhesive Provides Durable Bonds

Snyder Chemical Corp., Bethel, Conn., has announced a fast curing adhesive which is said to provide waterproof, durable bonds between porous and nonporous surfaces. With room temperature cure, joints normally can be handled within one-half to 3 hr after glue-up. With heat, cure can be effected in a few minutes.

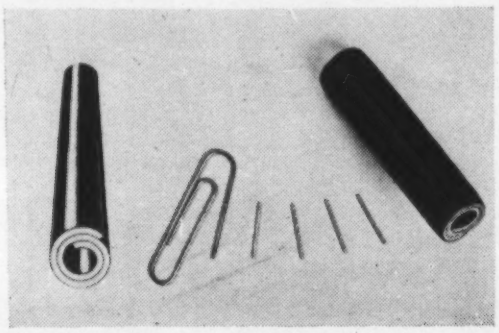
Synco 925 is claimed to do an outstanding job in bonding aluminum, stainless and porcelain-enameled steel to wood, honeycomb and plastics. It is described as a thermosetting copolymer emulsion producing tough, flexible films, and is recommended for typical applications where heat, water as well as solvent resistance are required.

Spiral Fasteners Now Produced In Small Sizes

C. E. M. Co., 24 School St., Danielson, Conn., manufacturers of the Spirol Pin, whose flexible coils are said to provide unique properties for fastening, has announced the addition of very small diameters to its full range of sizes. New diameters include 1/32, 0.052 and 3/64 in. made from stainless steel. Type 302 non-heat treated and Type 414 heat treated.

These diameters are expected to open up new applications where the spiral coil principle can be used to advantage. When compressed several thousandths on the diameter by driving or pressing into a hole, the pins provide radial spring action, tending to return the coils to normal position in relation to each other.

The new pins will be of particular interest to manufacturers of optical and camera equipment and other fine mechanisms and instruments. Now, for the first time, manufacturers of this type of equipment will be able to make use of the pin's advantages. These are said to include: ease of insertion, self locking features, elimination of close tolerances, reusability, elimination of internal stresses in component parts.



Ease of insertion, self-locking features and elimination of close tolerances are advantages provided by these Spirol Pins.

Spirol Pins are now available in a wide range of sizes, from 1/32- to ½-in. dia and from ⅛ to 4 in. in length.

Resin Surface Coating Has Unusual Properties

A newly developed plastic surface coating, designated Type X-5, which is said to demonstrate remarkable properties of adhesion to various surfaces (alloys of copper, steel, aluminum and magnesium), has been announced by *Furane Plastics,* 719 W. Broadway, Glendale 4, Calif.

Applied from solution, Type X-5 develops a thin, black coating ½ to 1 mil in thickness. After baking for an hour or more at 330 F or several minutes at 500 F, the coating is claimed to offer excellent adhesion to clean metal surfaces. Not only does the cured film possess good acid and alkali resistance, but also outstanding resistance to solvents as well as boiling aqueous solutions.

Another unusual quality claimed for the coating is that on a metal surface, it makes that surface much more receptive to adhesive bonding. Adhesives which normally possess poor adhesion to metals may find their bond strengths greatly improved if the metal is primed with X-5.

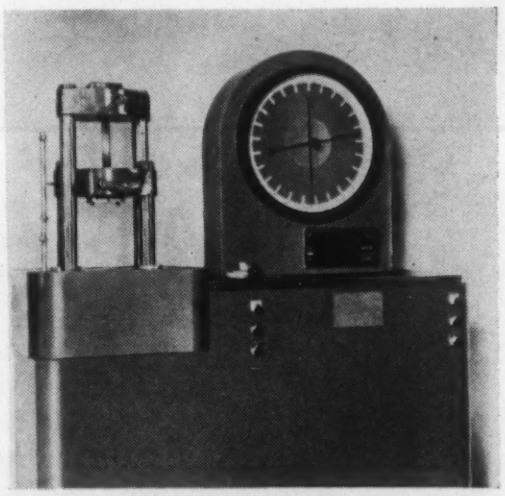
Universal Testing Machines Incorporate New Design

New models of Baldwin 60-H and 12-H testing machines have been announced by *Baldwin-Lima-Hamilton Corp.,* Philadelphia 42, Pa. The universal testers of 60,000- and 12,000-lb capacity, respectively, retain the many advantageous features of larger Baldwin testing machines provided in a low-cost testing unit.

Three changes in these units are most conspicuous. First, clear space between columns has been increased from 10 in. to 15 in. Second, without losing the advantages inherent in a two-unit design, the machine has been built as a single unit. Separate framework for the gage panel prevents the shock of breaking specimens from being transmitted to the load indicator. Third, both machines are now available with either of two types of indicators: one with two precision Emery 16-in. dia indicator dials, and the other with the more accurate Tate Emery Indicator with three ranges on a single 24-in. dial.

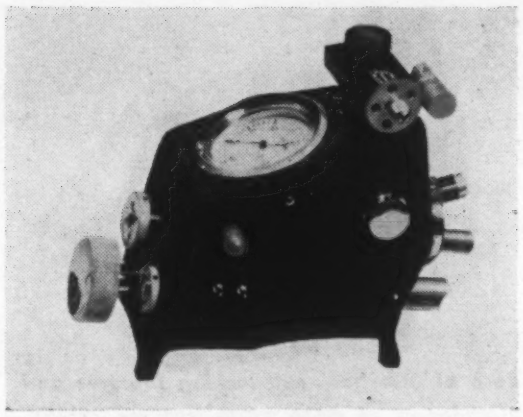
Both machines feature rigid loading systems consisting primarily of two cages. Load (either in tension or compression) is applied upward by a movable cage made up of the table of the machine and two columns supporting the upper gripping head. This cage is attached to the piston in a hydraulic cylinder in the base of the machine and has a 6-in. stroke. Loading speed can be varied infinitely between 0 and 2 ipm on the 60-H and between 0 and 4 ipm on the 12-H.

The units measure 67½ in. wide and 27 in. deep overall and have a height of 77½ in. over the indicator.



Many advantageous features have been combined in this low-cost testing unit.

New Materials and Equipment continued



This portable metal hardness tester tests ferrous and nonferrous metals in a wide range of sizes and shapes.

Portable Metal Hardness Tester Offered

The Penetrascope, a portable metal hardness tester said to employ the most accurate method of hardness testing known, is now being sold exclusively in this country by *C. Tennant, Sons and Co.*, 100 Park Ave., New York 17. The instrument tests ferrous and nonferrous metals in a wide range of sizes and shapes and is used on large or small work.

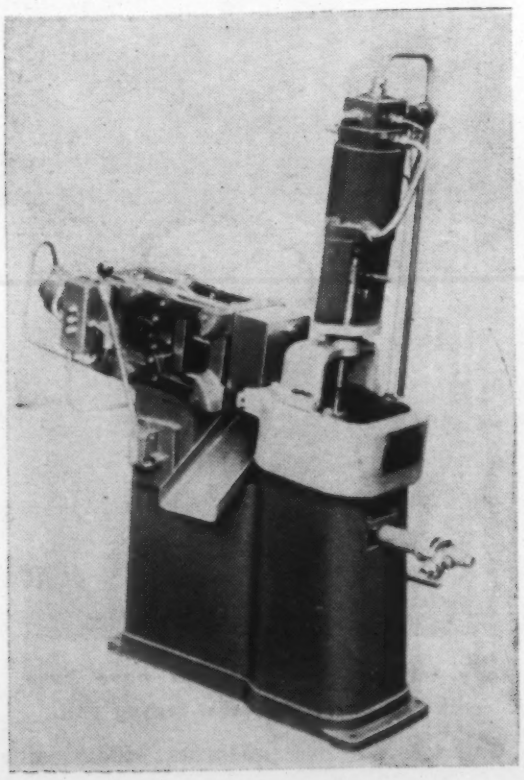
A variety of standard clamps—electromagnetic, chain and C-clamps are available, and others can be designed for special applications. A special combination of Penetrascope and electromagnetic stand can test many normally inaccessible parts of large assembled or partly dismantled units.

The instrument has a 136-deg pyramidal diamond indentor that makes a minute impression under controlled load, and the diagonals of the impression are measured within an accuracy of 0.001 mm. The load on the diamond indentor can be set at any point from one to 30 kilos to suit the hardness of the metal being tested. Ball type indentors of 1-and 2-mm dia are supplied for testing cast iron and other large grained metals.

Quick-Drying Strippable Protective Coating

A new sprayable, strippable coating is currently being tested by *Eagle Chemical Co.*, Industry Ave., Joliet, Ill. Capable of cold application by spray, brush or dip method, the product is said to be impervious to acids, alkalies, greases and oils and to afford good protection against vapors and abrasion.

Called Spray-Strip, it can be applied to either wood or metallic surfaces, dries in 20 min., and strips off in a single sheet. The product has been thoroughly tested by Foster D. Snell, Inc. and is now undergoing use tests in the automotive and aviation industries.



High-speed, high pressure injection is featured on this 1-lb zinc alloy die casting machine.

Die Casting Machine Features High Speed

High-speed, high pressure injection is said to be featured on the latest model 1-lb zinc alloy die casting machine currently offered by *DCMT Sales Corp.*, 164 Duane St., New York 13. The IMP/96 machine contains an injection system of the impact type whereby the piston area for injection is much larger than the area for piston return. This results in high-speed injection with no cushioning effect from the air trapped underneath the piston. In order to secure the greatest advantages from this type injection, the main valve is a pilot operated type, so that no throttling effect is undergone by the air going into the injection cylinder.

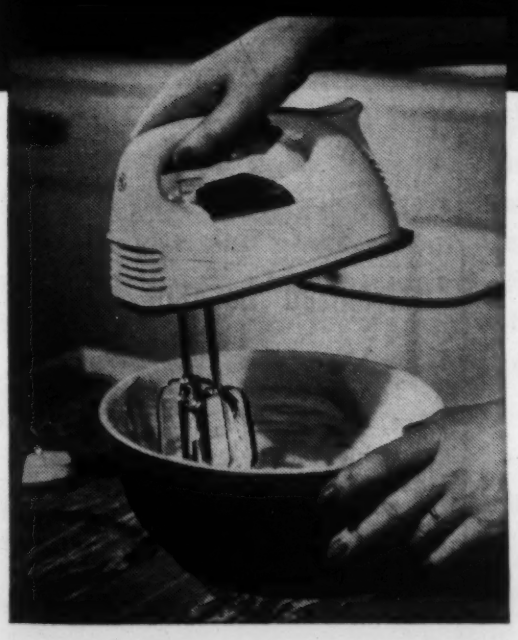
All of the basic advantages of DCMT diecastors, such as fast chilling, high cycling and automatic ejection of finished parts, are claimed to be retained in this unit, so that production runs of 800 to 1000 shots per hr can readily be obtained. One of the outstanding features of the machine is that it is designed to use small pre-fabricated die blocks, which are completely machined, except for the cavity itself. The use of these die blocks enables the manufacturer to use single cavity dies for their small parts, resulting in tremendous savings in die costs.

Weighing only 470 lb and taking up only 12 by 36 in. of floor space, the unit is applicable to an unusually wide range of products, including hardware, toys, appliance parts, jewelry and novelties.

(*More News on page 138*)

designed to sell with

HERCOCEL®



Housed in a new, flame-resistant Hercocel plastic, this Portable Mixer is General Electric's latest example of good styling and truly practical performance in kitchen aids. Flame-resistant Hercocel means not only added safety, but high impact strength . . . a lustrous, chip-proof finish . . . and a degree of operating quietness that's unattainable with other housing materials. Many large plastic units, heretofore impractical, are now made possible with this new, flame-resistant, high-impact Hercocel. For further information on Hercocel and the Hercules design assistance, technical counsel, and laboratory assistance that go with it, write or call:

HERCULES POWDER COMPANY
INCORPORATED
Cellulose Products Department, 996 Market Street, Wilmington 99, Del.

CP53-3

Pattern Cutting

by G. O. CARLSON, INC.

Saves TIME

Saves STAINLESS

This order for stainless plate was shipped by G. O. Carlson, Inc. "cut ready to finish," and it is typical of a great number of such jobs which we are regularly producing for critical applications.

The Carlson service in stainless steels begins with the plate itself, produced to chemical industry standards of quality. In addition, we have available our specialized facilities for laying out and pattern cutting plate to specifications.

This combination is making it possible for us to conserve vitally needed material in many cases — since it allows us to make best use of available stock with minimum scrap loss . . . and the customer receives his plate ready for final finishing prior to fabrication.

Stainless Steel is our only business . . . and we know it.

G. O. CARLSON, INC.

Stainless Steels Exclusively

200 Marshalton Road, Thorndale, Pa.

PLATES • FORGINGS • BARS • SHEETS (No. 1 Finish)

District Sales Offices in Principal Cities

New Materials and Equipment

Sub-Zero Freezers for Testing

Low temperature testing is now said to be practical for any size laboratory or test department with the new XV-70 Series industrial chilling machines announced by *Sub-Zero Products Co.*, 3930 Reading Rd., Cincinnati 29. The new unit will hold any temperature from —10 to —70 F and has a thermal capacity of 500 Btu per hr.

For wide flexibility in application, the XV-70 will be available in chilling chamber sizes ranging from 5 down to 1.5 cu ft. Since the unit is designed primarily for testing, the largest chilling chamber dimensions will be 30 by 18 by 16 in deep. In view of the chilling chamber capacities, the XV-70 Series is unusually compact in overall size; this is made possible by the use of highly efficient insulation and a hermetically sealed motor compressor.

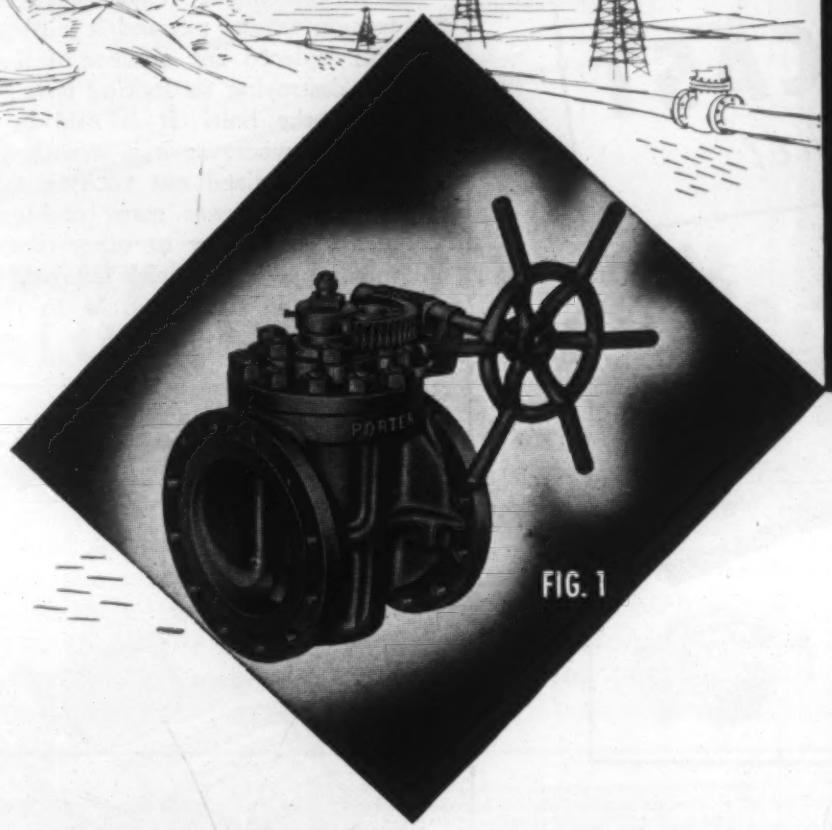
Of all steel construction, the unit has a chilling chamber wall of 3/16-in. steel to facilitate the handling of heavy or sharp-edged metal parts. The lid is counter-balanced. Special design is said to eliminate moisture condensation on the outside of the lid and cabinet. The Series is a companion line to the recently announced Series XV-120, which is built in the same sizes and capacities, but with a temperature range from —70 to —140 F.

Galvanized Locknut for Corrosive Locations

The Security Locknut Corp., North Ave. & 15th Ave., Melrose Park, Ill., has announced the development of a locknut that can be hot-dip galvanized. The new fastener has a square body and holds its position on the bolt by means of the Security locking insert.

The locking insert is a slightly ellipti-

FOR SECURITY IN THE FIELD



Porter Plug Valve Bodies are MEEHANITE CASTINGS

The Porter Valve Division of the H. K. Porter Company, Tulsa, Oklahoma, build a line of lubricated plug valves, Fig. 1, all of which are pressure castings subjected to a variety of combined and severe service stresses in the field. These stresses include high pressure, tensile and compressive forces, impact and distortion. The company, in describing their reason for the Meehanite specification states, "Porter finds Meehanite Metal provides an extra protection against cracking."

A not too infrequent problem in pipe line installation is the cracking of valve body flanges. This problem arises when the pipe line is not true. The combined high tensile strength, toughness and pressure tightness due to uniform density provided by Meehanite castings, Fig. 2, make them the logical solution to the problem involved. Porter Meehanite Valve Bodies are produced in sizes ranging from ½ inch to 24 inches.

This application is another example of how "Meehanite Bridges the Gap Between Cast Iron and Steel"—combining the better properties of both.

MEEHANITE FOUNDRIES

American Brake Shoe Co.	Mahwah, New Jersey
The American Laundry Machinery Co.	Rochester, New York
Atlas Foundry Co.	Detroit, Michigan
Banner Iron Works	St. Louis, Missouri
Barnett Foundry & Machine Co.	Irvington, New Jersey
E. W. Bliss Co.	Hastings, Mich. and Toledo, O.
Builders Iron Foundry	Providence, Rhode Island
Compton Foundry	Compton, Calif.
Continental Gin Co.	Birmingham, Alabama
Crawford & Doherty Foundry Co.	Portland, Oregon
The Cooper-Bessemer Corp.	Mt. Vernon, Ohio and Grove City, Pa.
De Laval Steam Turbine Co.	Trenton, New Jersey
M. H. Detrick Co.	Newark, N. J. and Peoria, Ill.
Empire Pattern & Foundry Co.	Tulsa, Oklahoma
Farrel-Birmingham Co., Inc.	Ansonia, Connecticut
Florence Pipe Foundry & Machine Co.	Florence, New Jersey
Fulton Foundry & Machine Co., Inc.	Cleveland, Ohio
General Foundry & Manufacturing Co.	Flint, Michigan
Greenlee Foundry Co.	Chicago, Illinois
The Hamilton Foundry & Machine Co.	Hamilton, Ohio
Hardinge Company, Inc.	New York, New York
Hardinge Manufacturing Co.	York, Pennsylvania
Johnstone Foundries, Inc.	Grove City, Pennsylvania
Kanawha Manufacturing Co.	Charleston, West Virginia
Koehring Co.	Milwaukee, Wisconsin
Lincoln Foundry Corp.	Los Angeles, California
London Concrete Company, Ltd.	Brantford, Ontario
E. Long Ltd.	Orillia, Ontario
Otis Elevator Co., Ltd.	Hamilton, Ontario
Palmyra Foundry Co., Inc.	Palmyra, New Jersey
The Henry Perkins Co.	Bridgewater, Massachusetts
Pohlman Foundry Co., Inc.	Buffalo, New York
Rosedale Foundry & Machine Co.	Pittsburgh, Pennsylvania
Ross-Meehan Foundries	Chattanooga, Tennessee
Shenango-Penn Mold Co.	Dover, Ohio
Sonith Industries, Inc.	Indianapolis, Ind.
Standard Foundry Co.	Worcester, Massachusetts
The Stearns-Roger Manufacturing Co.	Denver, Colorado
Traylor Engineering & Mfg. Co.	Allentown, Pennsylvania
Valley Iron Works, Inc.	St. Paul, Minnesota
Warren Foundry & Pipe Corporation	Phillipsburg, New Jersey

"This advertisement sponsored by foundries listed above."

Write for our new Bulletin #37 entitled— "Proof That Meehanite Bridges the Gap".

MEEHANITE®

NEW ROCHELLE, N. Y.

MEEHANITE MEANS BETTER CASTINGS

Qualified

DIMENSIONALLY...

To further assure duplicate exactness *Unitcast* will accept or design for you *qualifying gauges* incorporating machine fixture locators to points given by your tool engineers.

PERUSE THESE FACTORS...

1 Do your machining and assembly time allowances fluctuate out of allowable control limits due to casting variances?

2 Could you eliminate costly machine operations if your cast parts were held to mutually accepted tolerance limits?

3 Would the elimination of just one machine operation facilitate a greater overall production flow in the line set-up?

Are these factors a problem to you? If so, may we at *Unitcast* urge you to call upon our sales engineers and technical staff who are constantly transforming these problem questions into answered realities.

UNITCAST
Corporation
QUALITY STEEL CASTINGS

Give us a chance to offer a "cast steel" answer for your parts problem. Our suggestions while your product is in the design stage will pay continuous dividends.
Write or call today. Unitcast Corporation, Steel Casting Division, Toledo 9, Ohio. In Canada: Canadian - Unitcast Steel, Ltd., Sherbrooke, Quebec.

UNITCASTINGS are ***FOUNDRY ENGINEERED***

New Materials and Equipment

cal, heat treated retainer ring of spring steel. When the nut is applied, the bolt forces the retainer into the round, causing the retainer to grip the bolt with high-tension strength. It does not require bolt tension to stay put and it can be removed and replaced any number of times without destroying its locking power or damaging the bolt. It is said to hold its position wherever it is wrenched.

A galvanized nut such as this is expected to answer many problems where alkali, salt water or other corrosive elements play havoc with nuts and bolts. It is made in sizes from 3/8 to 1 3/8 in.

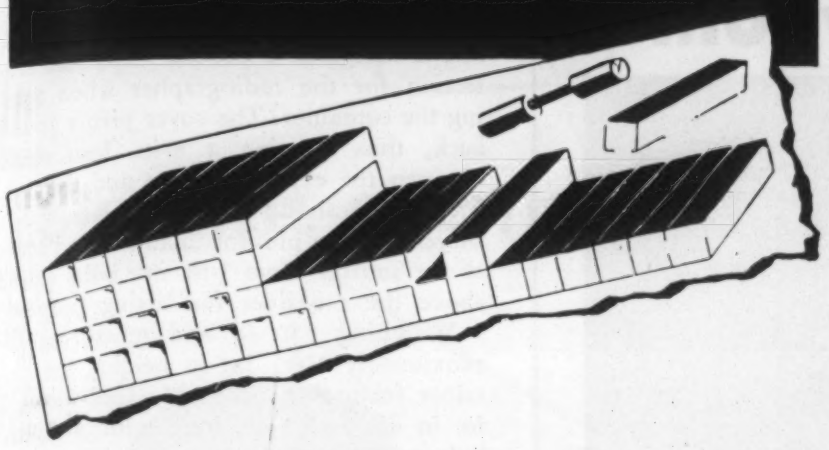
Shielding Container for Cobalt 60 Used in Radiography

A new high intensity shielding container for the shipping and storage of Cobalt 60 radiography or other industrial sources has been developed by *Tracerlab, Inc.*, 130 High St., Boston, Mass. The new container will hold up to approximately 800 millicuries of activity. The radiation from an 800-mc Cobalt 60 source will be less than 10 milliroentgens per hr at 1 meter.

The E-31B container is made of an outer shell of 3/8-in. malleable iron which is filled with lead. The lead filling, plus the iron outer surface, provides an effective shielding which is said to be the equivalent of 4 in. of lead.

A unique, hinged, wedge-shaped cover lifts up from the center of the container

If You Want the Quality of the TEST BAR in Your Castings!



Specify FRONTIER 40-E ALUMINUM ALLOY!

● Ordinarily the physical properties of an aluminum-alloy casting are less than those of a separately-cast test bar. But because of the special qualities of FRONTIER 40-E—the *non-heat-treated* aluminum alloy—you can be sure that *the same high qualities which show up in the test bar will appear uniformly throughout a large casting.* The following tables tell the story:

40-E Step Block Casting Cut Into 42 Test Bars—Physical Properties of each Shown in Squares.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Y.S.	22.5	20.0	21.2	20.6	20.5	22.0	20.8	21.0	21.8	22.5	23.0	23.4	23.0	25.0	23.8	22.5	23.5	24.6
T.S.	38.3	33.0	33.1	32.7	33.8	36.0	33.8	32.5	33.5	34.5	34.0	37.2	37.8	39.0	36.8	36.5	36.7	40.0
El.	12.5	10.0	6.0	4.0	7.5	7.5	8.0	7.0	7.0	7.5	7.0	8.0	8.5	8.5	7.5	8.0	7.5	10.0

	30	29	28	27	26	25	24	23	22	21	20	19
Y.S.	22.0	23.0	22.5	21.5	22.5	23.5	22.5	23.5	23.5	23.8	22.8	23.8
T.S.	36.3	35.3	35.3	35.0	35.0	37.3	34.5	32.0	32.5	32.5	35.0	38.3
El.	10.0	6.0	9.0	7.5	7.5	6.0	5.0	5.0	5.0	5.0	7.5	7.5

	31	32	33	34	35	36
Y.S.	23.0	22.8	22.5	24.0	23.5	23.0
T.S.	36.3	33.3	32.5	32.5	36.3	39.0
El.	8.0	5.0	5.0	5.0	7.0	8.5

	42	41	40	39	38	37
Y.S.	23.3	23.7	23.0	23.2	23.0	22.5
T.S.	33.2	37.1	36.4	37.3	38.0	40.8
El.	3.0	8.0	6.5	6.5	11.0	11.0

Separately-Cast Test Bar Properties		
NAT. AGED 21 DAYS	Y.S.	23500
	T.S.	36600
	El.	7.5

PROPERTIES OF CASTING (BASED ON TENSILE STRENGTH READINGS)			
	Maximum	Minimum	Average
Y.S.	25,000	22,500	22,700
T.S.	40,800	32,500	35,500
El.	11.0	5.0	7.5

Write TODAY for full details about Frontier 40-E Aluminum Alloy . . . including FREE DATA BOOK.

S. A. E.	310
A. S. T. M.	B-26-50T Alloy ZG-61A (Castings)
A. S. T. M.	B-179-51T Alloy ZG-61A (Ingots)
Federal	QQ-B-601a Comp. 17
Navy	QQ-B-601a Comp. 17 46A-1-Class 1
Air Corps	QQ-B-601a Comp. 17

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New Materials and Equipment

and is designed to provide maximum protection for the radiographer when opening the container. The cover pivots up and back, thus erecting a 4-in. lead shield between the exposed source and the user. The cover can be locked in place with a bicycle lock to prevent unauthorized access to the source. Two 1-in. eye bolts extend above the container for lifting purposes.

Weighing 150 lb and measuring approximately 10¾ in. in height, the container features a removable lead insert, 1 in. in dia and 1 in. long with a tapered hole to accept the source.

Silicon Bronze Alloy for Castings

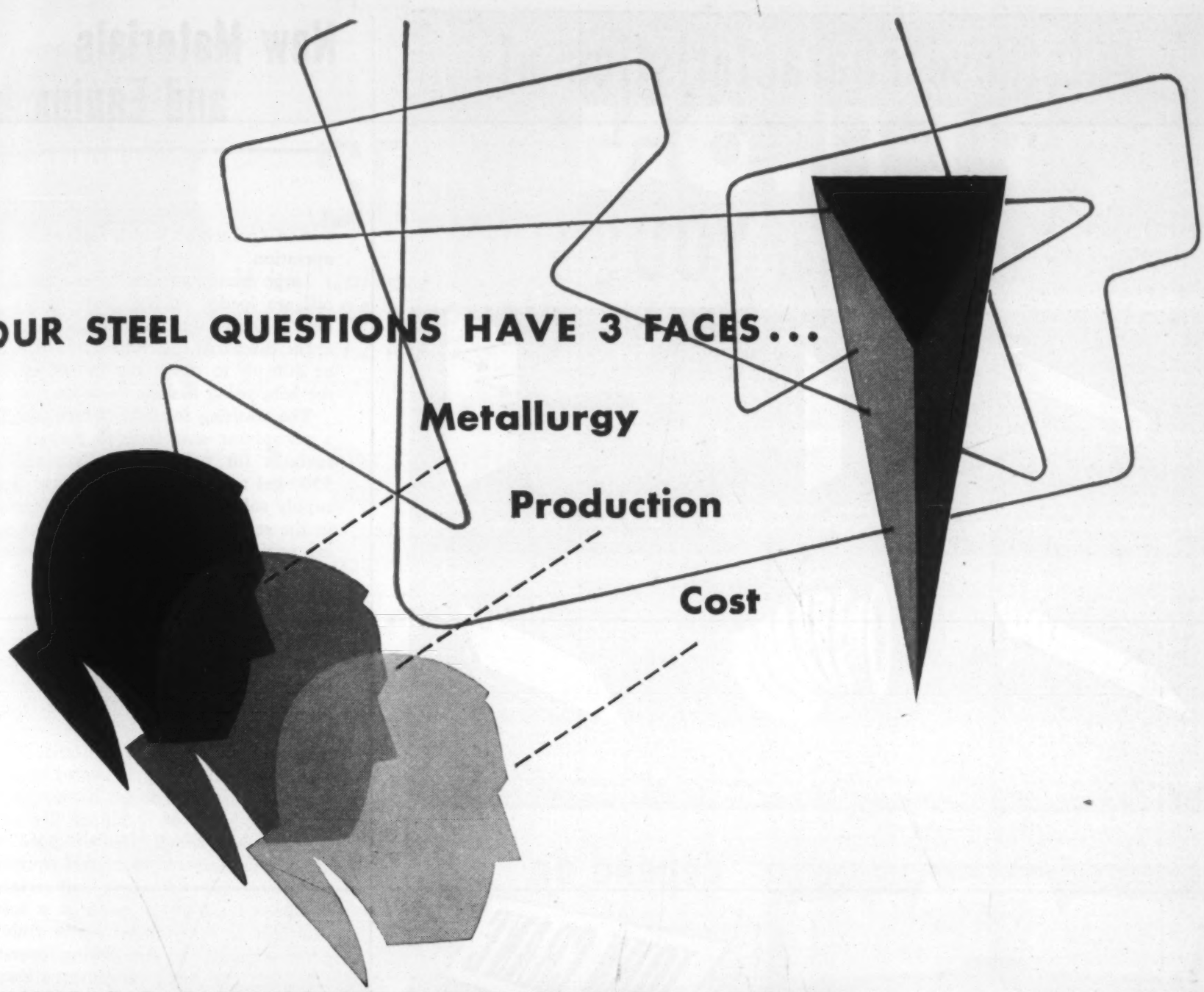
Alloys and Products, Inc., 1101 Oak Point Ave., New York 59, has announced that they are now producing and marketing Everdur ingot for the foundry industry. Everdur is a silicon bronze possessing high strength and corrosion resistance equivalent to pure copper. Its superior properties and good casting qualities permit its use in engineering applications where ordinary brass and bronze will not stand up.

The name Everdur is a copyrighted trade mark of The American Brass Co., under whose licensing agreement the product will be made and sold. Chemical and metallurgical quality of the metal will be held to the rigid specifications of the American Brass Co. by a frequent interchange of test samples between the two companies.

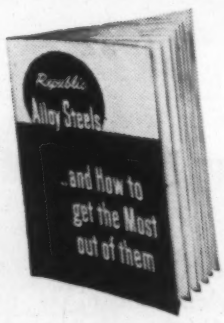
Twin-Tunnel Metal Washing Machine Saves Space

A new metal cleaning machine, featuring a two-in-one space saving design, has been announced by *Cincinnati Cleaning & Finishing Machinery Co.,* Schmidt Bldg., Cincinnati 2.

The unit has a tunnel in which parts carried on the plant monorail conveyor system are washed, above a tunnel through which miscellaneous large and small parts are carried on a wire mesh belt through washing, rinsing and drying operations. Parts on the monorail system are carried through the washing machine without attention, being loaded at the preceding work station and unloaded at the work



REPUBLIC 3-DIMENSION METALLURGICAL SERVICE



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LOOKS AT ALL THREE—Whatever you make . . . or plan to make . . . these 3 questions dictate your decision on steel grades. When leading fabricators, small or large, have any question about the right answer, they call in a Republic Field Metallurgist. They know that his final recommendations on alloys, machining, and heat-treating procedures will include the opinions of the other two members of the Republic 3-Dimension Metallurgical Service team . . . a Mill Metallurgist and a Laboratory Metallurgist.

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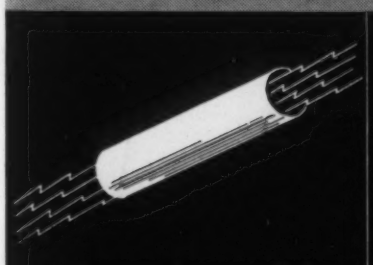
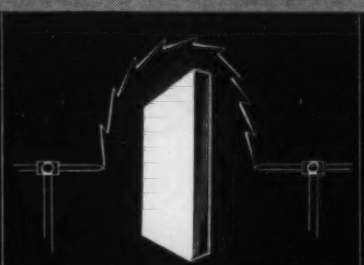
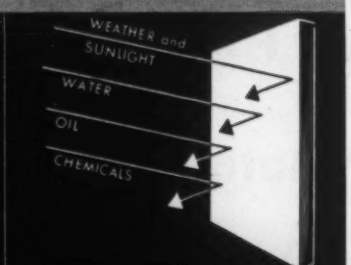
Put these characteristics of TEFLON* to work for YOU!



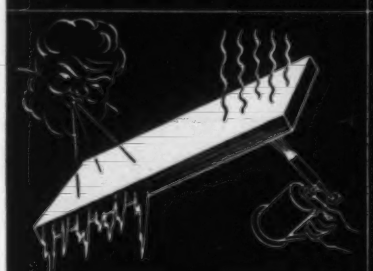
1 Full electrical flow (low radio frequency loss factor) with Teflon. Power factor .0005.



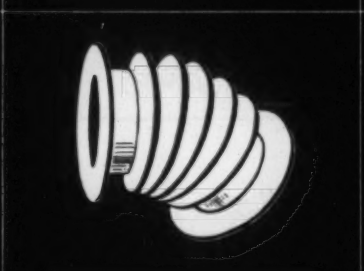
2 High dielectric strength—1000 to 2000 volts/mil, in thicknesses of 5 to 12 mils.



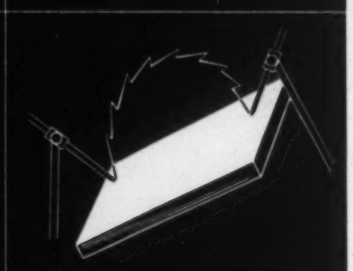
3 Teflon is impervious to weather, sunlight, water, oil, and all chemicals.



4 Teflon retains its toughness over a very wide temperature range (−94° F. to +482° F.)

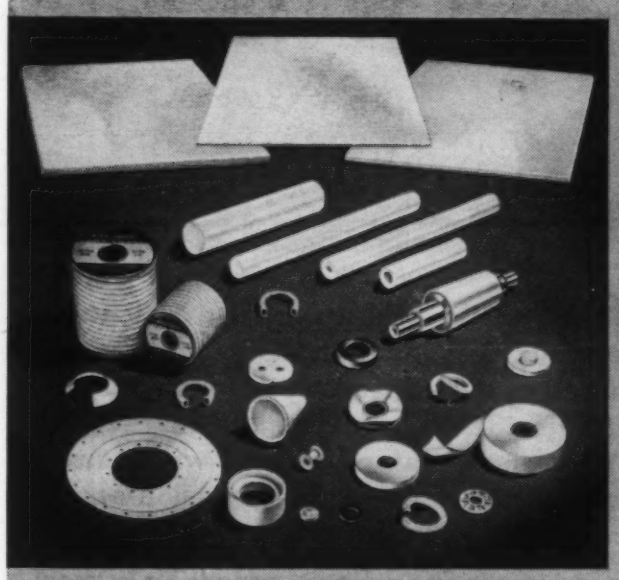


5 Teflon flexes, has good tensile strength, won't crack under vibration and has high impact strength.



6 Teflon prevents a carbonized conduction path that other materials permit.

*DuPont Trade-mark for tetrafluoroethylene resin



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Since the very inception of Teflon, "John Crane" has geared their engineering talents and facilities to develop its possibilities for manufacturers of electrical and chemical equipment. As a result, "John Crane" is ready to work with you in recommending and designing Teflon component parts best suited to your special requirements.

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New Materials and Equipment

station (painting) which follows cleaning operation.

Large parts not carried on the monorail are loaded on the conveyor belt section of the washer and manually unloaded at the discharge end. Smaller parts, fragile or difficult to clean, can be processed on the belt, using baskets or racks.

The washing solution, which may have a phosphoric acid base to prepare metal surfaces for painting, is contained in a 3500-gal tank. From this tank, two pumps supply solution to the spray arrangements in the respective belt and monorail washing sections. With a manifolding arrangement, the solution delivered by both pumps can be applied in either spraying section or divided between the two sections in any proportion. A similar arrangement is used in the rinsing section, pumping from a 2250-gal tank. Both solution tanks are heated with 90 psi steam, using removable plate coils. Float valves maintain solution level automatically.

Air used in drying is heated by a dual set-up of mixing type gas burners supplying a maximum of 6 million Btu per hr. Burners are completely equipped with safety and temperature control equipment. Two large blowers apply and recirculate the heated air to the parts at a velocity sufficient to strip excess water from the parts, simplifying the drying operation. Here, too, the dual arrangement allows the operation of either or both sections of the unit.

Anti-Sticking Finish for Machinery Parts

A new material, known as Teflon polytetrafluoroethylene finish, is finding increasing use in the textile industry as a coating on machinery parts, chiefly because practically nothing will stick to it, according to recent reports from *E. I. du Pont de Nemours and Co., Inc.,* Wilmington, Del. To date, most extensive application of Teflon in this field is on slasher cylinders where it is said to greatly prolong the period between clean-ups.

This teflon finish is a specially compounded aqueous dispersion. It is sprayed by conventional methods and fused at around 700 F.

In addition to its anti-sticking property, the finish is unaffected by any of the chemicals normally used in the textile industry. There is no known solvent for Teflon. It has, moreover, a low coefficient of friction, being slippery or waxy to the

SPENCER HARTFORD TURBOS

FOR SPECIAL OCCASIONS

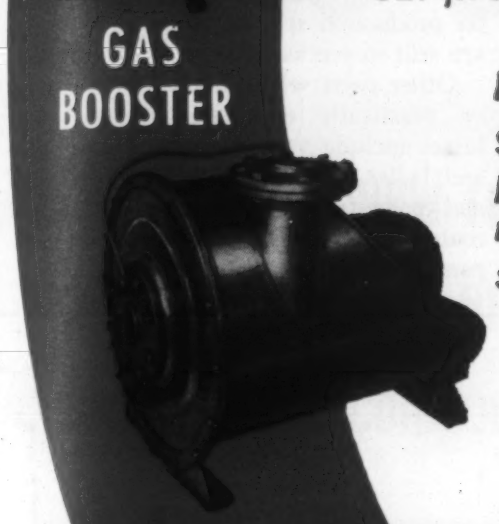
Standard motor driven Spencer Turbos are listed in more than 160 sizes. For special applications, there are many variations, six of which are illustrated.

Spencer Turbos range in size from 35 to 20,000 cu. ft. per min. 4 oz. to 10 lbs. and 1/3 to 1,000 h.p.

For complete description of the standard and special Turbos ask for Bulletin No. 126-A.

MIDGET

With universal motor, 35 to 75 cfm at 12 to 40 oz. pressure

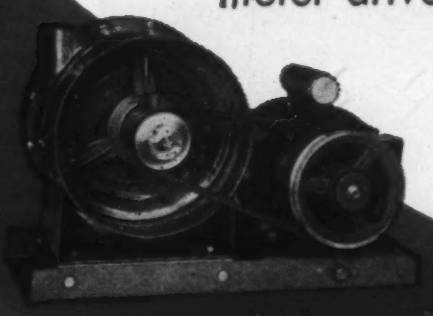


GAS BOOSTER

For handling gas, acid fumes, poisonous, corrosive or explosive gases

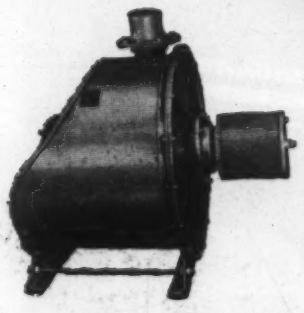
4 BEARING

Overhang or outboard type for coupled drive



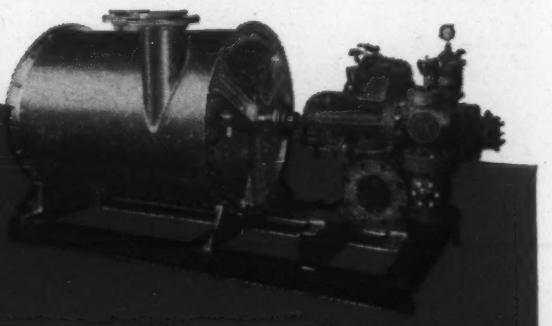
BELT DRIVE

For odd frequency or other than electric motor driven



AIR FILTERS

Of various types for intake of Turbo



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For use where it is desired to operate with steam

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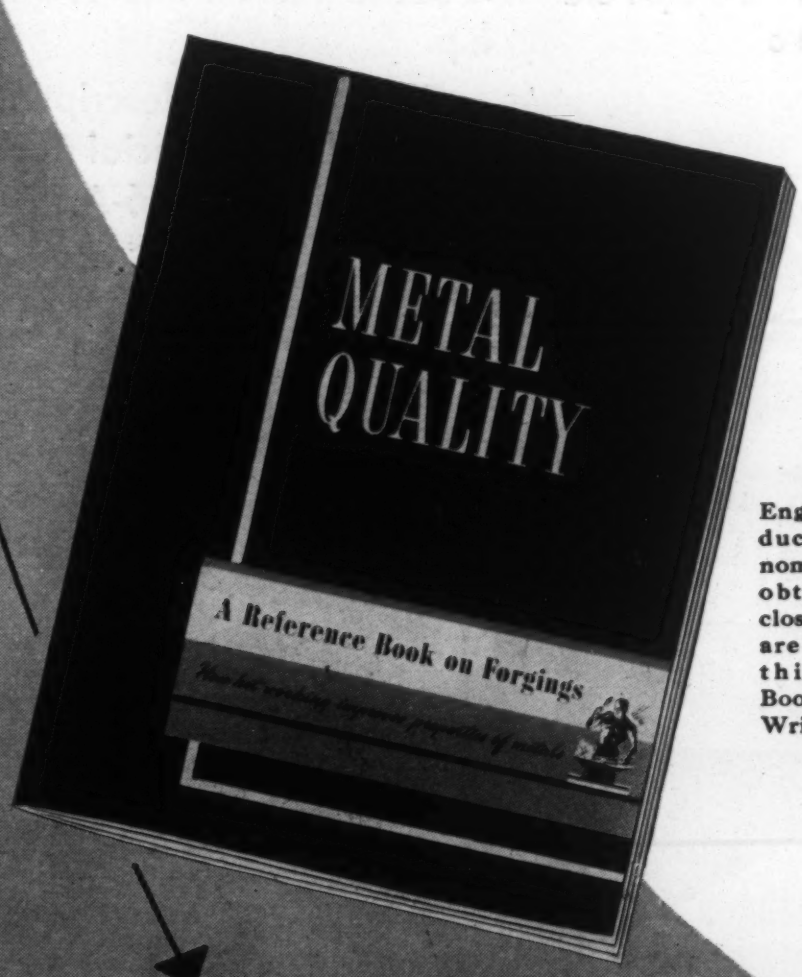
Forgings—closed die forgings—with their unmatched economic and mechanical advantages offer quick and complete solutions for Problem Parts problems confronting any member of a production team.

Consult a forging engineer about the closed die forging process for producing parts with the correct combination of mechanical properties required for your product.



Engineering, production and economic advantages obtainable with closed die forgings are presented in this Reference Book on Forgings. Write for a copy.

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Please send 60-page booklet entitled "Metal Quality — How Hot Working Improves Properties of Metal," 1949 Edition.

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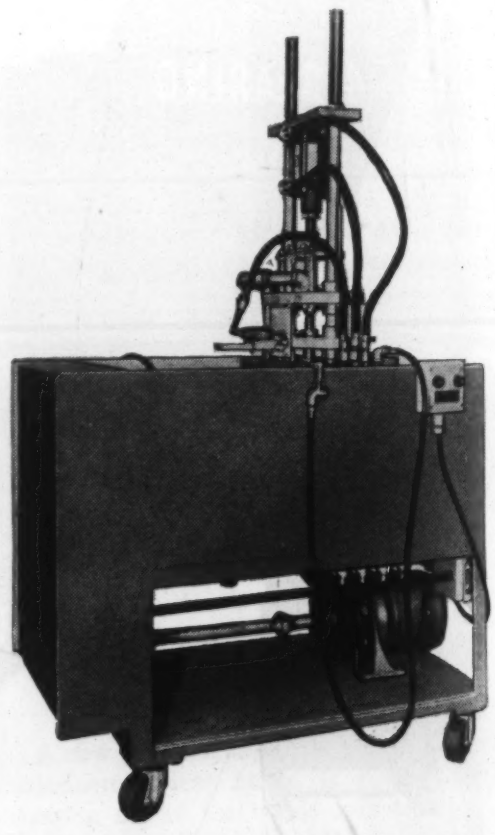
New Materials and Equipment

touch. The material remains solid up to 620 F. Maximum recommended operating temperature is 480 F, although it is used in several instances at 550 F.

Sizing liquids will not stick or build up on coated drying cans, thus making heat transfer more efficient and permitting faster production speeds. Some of these cans are still in service after more than 2 years.

Other parts where nonadhesion reduces or practically eliminates "down" time losses include vats, troughs, drums, pails and ladles. Metal feed rolls, scroll rollers and tenter frame pin plates have also been coated successfully, according to the company.



New Machine Quenches Holes in Producing Case Hardened Dies

A new unit, the I.D. Hole Quencher, which is said to put into a scientific and automatic cycle of operations all those factors concerning temperature of the die, temperature of the coolant, timing of coolant exposure, etc., has been announced by the *Palmer Manufacturing Co.*, 3790 Ridge Rd., Cleveland.

According to the company, the unit is completely automatic: the heated die-blank is placed into position on the anvil; air operated rams contact above and below, holding a fitting tightly against die. When proper contact is made, brine or

SPEED PRODUCTION, CUT COSTS ON LARGER PARTS

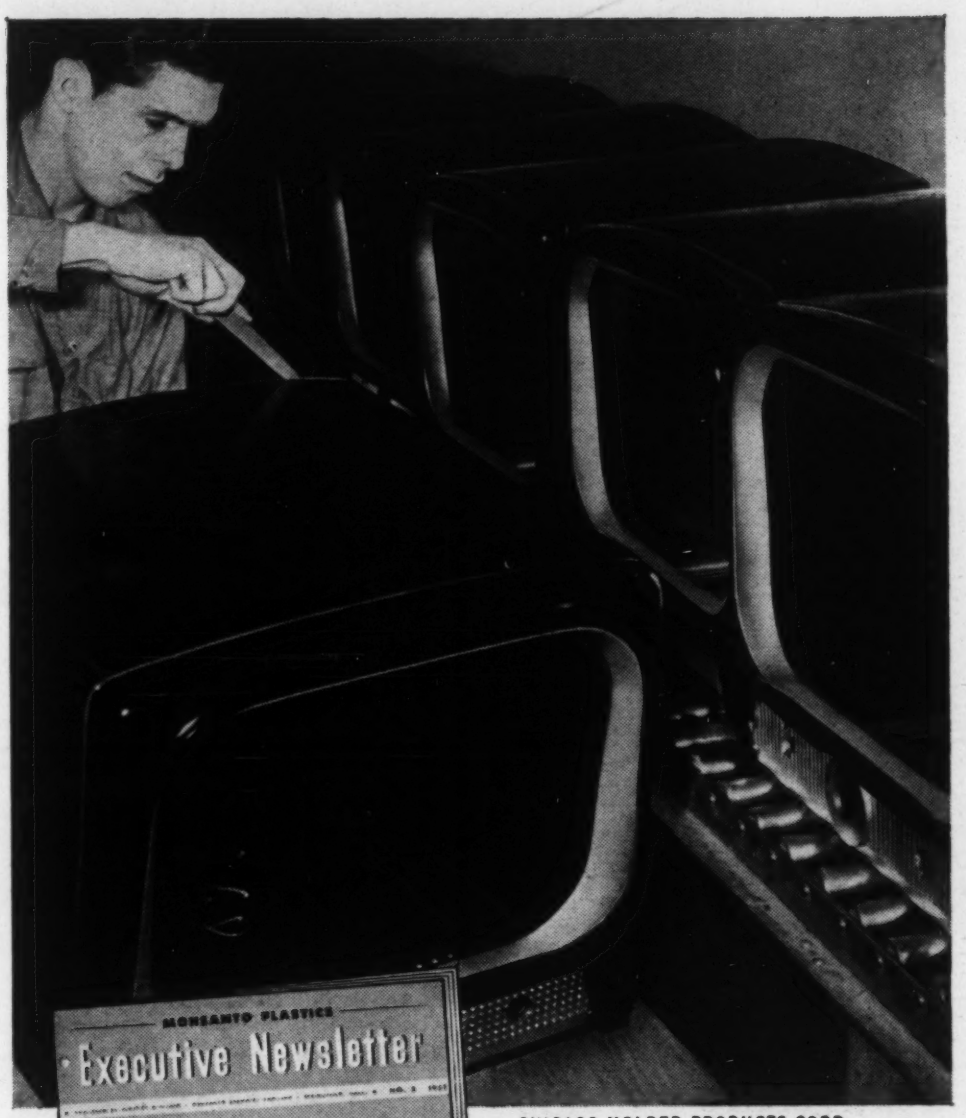
You'll want this new report on recent developments in mass-producing giant components

You may already have turned to plastics to solve some of your design and production problems for small parts. But today, with larger and larger plastic moldings possible, you may be asking this question:

"Can I realize the same considerable production advantages on *large* components that I'm now enjoying with small plastic moldings?"

To answer your question authoritatively, Monsanto has issued a report that tells how product designers can now consider new giant plastics applications that were out of the question a few short years ago—because of huge new molding machines, improved plastics formulations, and the continuing progress in plastics molding technology.

We think you'll be interested in this new study, which shows *how* leading manufacturers are already using plastics to simplify production and cut costs on ever-larger component parts. For your free copy, please mail the handy coupon.



CHICAGO MOLDED PRODUCTS CORP.

FREE—REPORT TO DESIGN ENGINEERS

Monsanto's latest study, on how "one-shot" plastic moldings of giant parts can simplify production, cut costs.

MONSANTO CHEMICAL COMPANY, Plastics Division, Room 2227, Springfield 2, Mass.

Please send me your report on how plastics simplify production of large units.

Name & Title _____

Company _____

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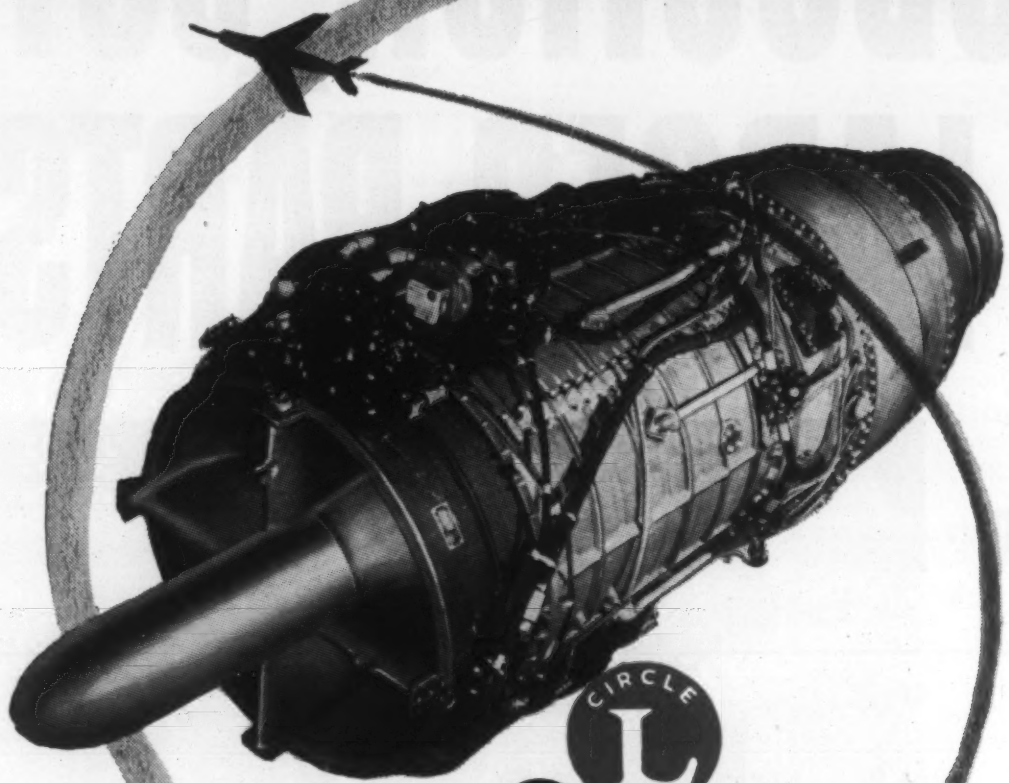


LEBANON Castings ARE AT WORK

THAT streak in the sky is a Curtiss-Wright Sapphire J-65 Turbo Jet Engine powering a high-altitude plane. The intense heat—approximately 1500° F.—developed during flight is enough to disintegrate "normal" materials, formed in the usual way. Yet in this inferno of power Lebanon Stainless Steel Centrifugal* Castings of special heat-resistant alloys are giving dependable service as . . .

TURBINE SHROUDS
HEAT SHIELD SUPPORTS
EXHAUST CONE FLANGES
COMBUSTION CHAMBER FLANGES
TURBINE BLADE SPACER RINGS

*"*CENTRI-DIE*", *patented name for method of casting steel centrifugally in metal molds, under license agreement with Firth-Vickers Stainless Steels Limited, Sheffield, England. Lebanon also makes steel castings, both static and centrifugal, in refractory molds.*

Have you seen . . .
STEEL WITH A THOUSAND QUALITIES?

This 37-min., 16 mm., full-color sound film showing steel castings from blueprint to end use should be shown to your organization. For information, write: Dept. D, Lebanon Steel Foundry, Lebanon, Pa.

LEBANON Castings
CARBON, SPECIAL ALLOY AND STAINLESS STEEL
LEBANON STEEL FOUNDRY LEBANON, PA.

New Materials and Equipment

other solution is pumped through the die hole. When hole quenching is completed, depending on hardness required and area and depth of surface, a kick-out ram automatically pushes blank into tank for overall cooling. All timing, temperature and pumping operations can be set on a predetermined cycle and push button operated by the worker.

The new machine is adjustable to handle from 1/16- to 3-in. I.D. holes in blanks ¼- to 8-in. O.D. and from 1/16 to 6 in. long.

New Method for Aligning Fixtures

A new and faster method of aligning aircraft jigs and fixtures has been developed by the *United States Testing Co., Inc.,* 1415 Park Ave., Hoboken, N. J.

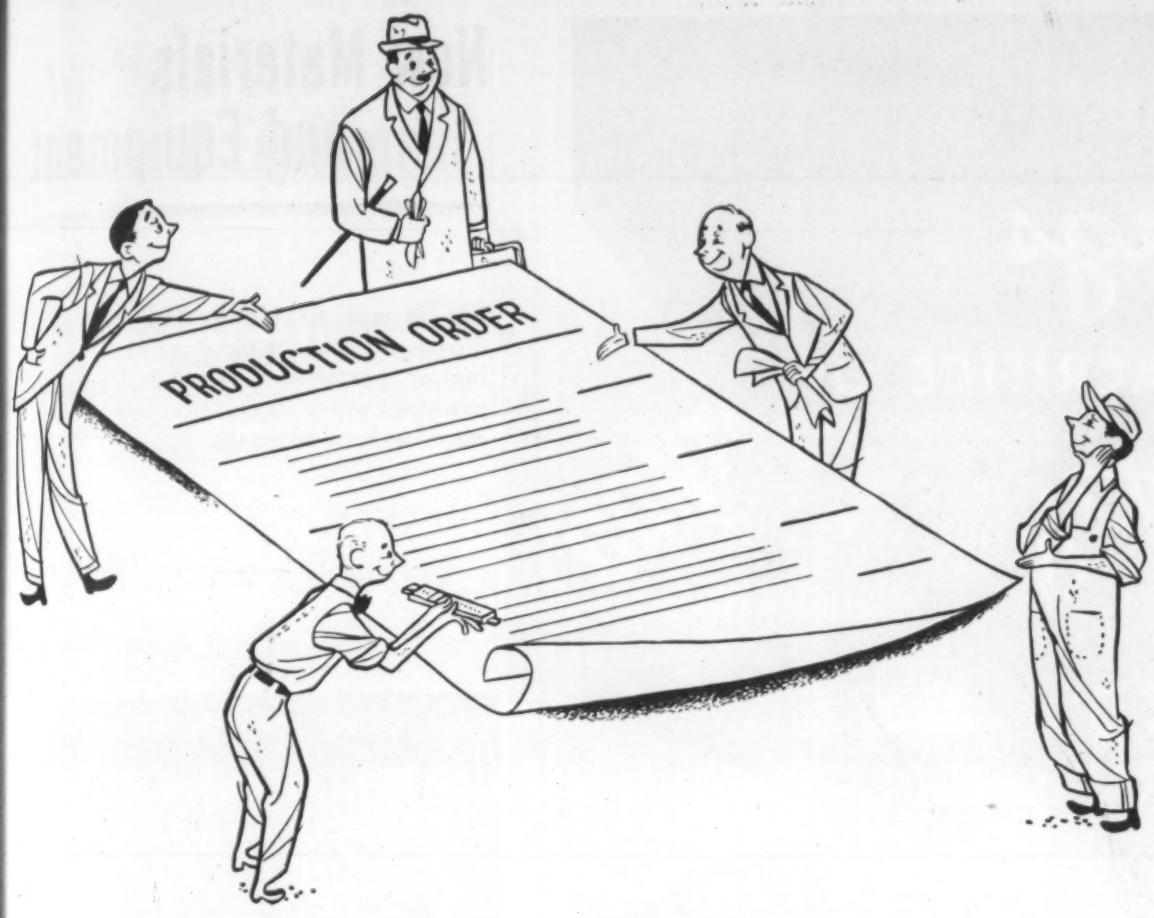
The new stand has a cast iron base and is readily adjustable for carefully controlled change in position of the instrument and in leveling. The stand can be moved about without difficulty, and releveling or alteration of the stand base is not necessary. The importance of this feature cannot be underestimated when parallel reference measurements are being made. Precise horizontal plane relocation is said to be made with two positioning screws. The base screw adjusts the height at will.

Versatile Hard-Facing Alloy

Good resistance to abrasion at high temperatures, the ability to withstand attack by molten copper, and improved welding characteristics are some of the features claimed for CM-119, a new hard-facing alloy manufactured by *Coast Metals, Inc.,* Little Ferry, N. J.

Because of its ability to resist abrasion at the temperature of hot-rolled steel, CM-119 has already found successful application as hard facing for large guide rolls and as hot friction guides and soaking tong bits. Its resistance to attack by molten copper permits the alloy to yield excellent results as protection for the lips of copper converters.

CM-119 can be applied with any good arc welding process. It has easy welding characteristics that assure efficient bond-



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Because that's the way we make sure that your order for alloy steel gets careful, individualized supervision . . . painstaking attention to every processing detail right from the front office, through our laboratories, down to the men who roll your steel.

Let us show you how our *personal touch* assures you of alloy steels that are truly tailored to your specialized requirements.

Write or call Claymont Steel Products Department, Wickwire Spencer Steel Division, Claymont, Delaware.

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WICKWIRE SPENCER STEEL DIVISION—Atlanta • Boston • Buffalo • Chicago • Detroit • New York • Philadelphia
CANADIAN OFFICES: Toronto • Winnipeg • Edmonton • Vancouver

CLAYMONT STEEL PRODUCTS

PRODUCTS OF WICKWIRE SPENCER STEEL DIVISION
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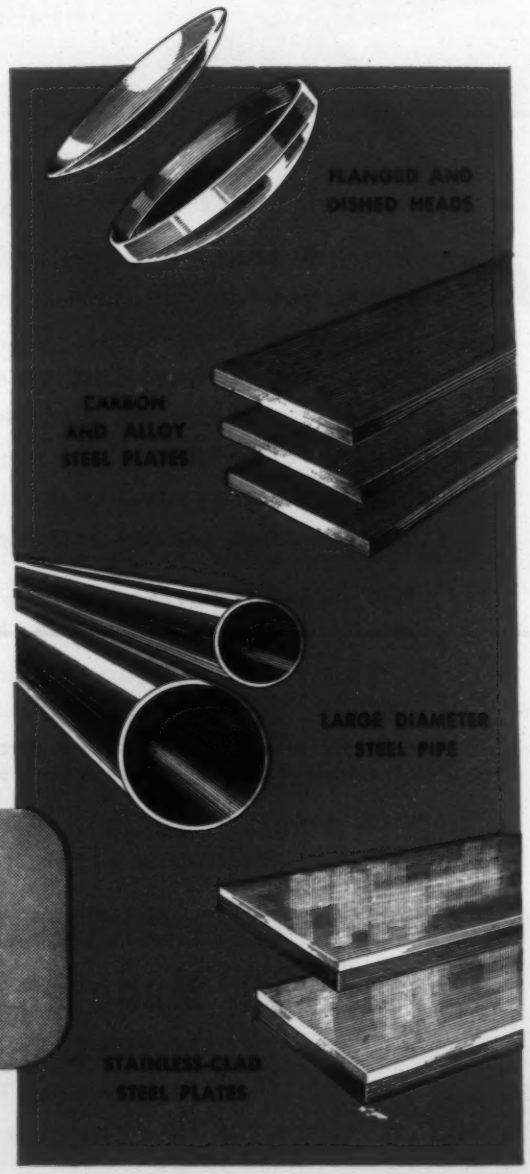

SUBSTANTIAL
Savings
WITHOUT SACRIFICE OF
Quality
with
HITCHINER
PRECISION
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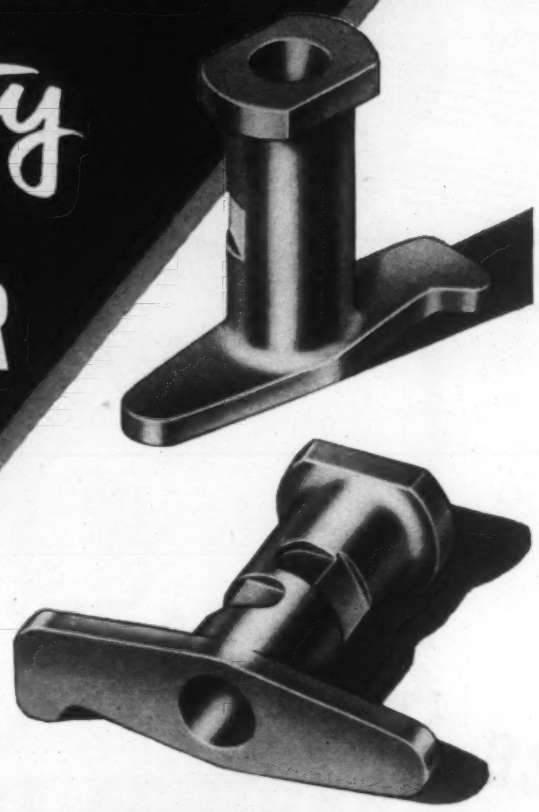
CASTINGS



Torque Tube for Gyroscopic Application Investment Cast from S Monel ACTUAL SIZE

Mr. J. B. Lyons* tells us that in the pilot construction stages this torque tube was fabricated in two parts, the flange and the tube and then they were brazed together. Then Hitchiner Precision Investment Castings entered the picture. The resultant saving in turning, profiling, milling, drilling and boring and the elimination of the brazing meant a tremendous saving in cost . . . AND as Mr. Lyons says: "All this has been accomplished without sacrifice of quality."

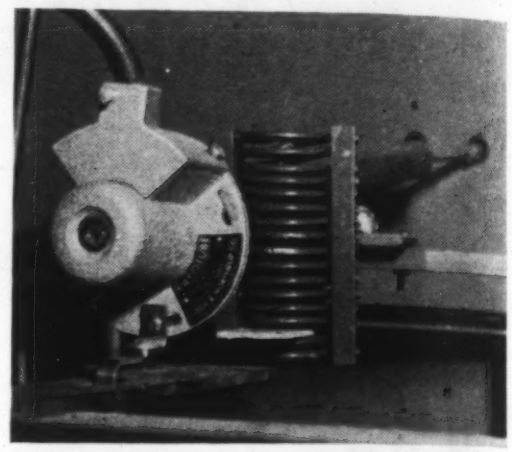
*Mr. Lyons is Purchasing Agent of the Doelcam Corp., Newton, Mass.

This free folder tells you more about Hitchiner Precision Investment castings . . . send for it today

HITCHINER Manufacturing Company, Inc.
MILFORD 3, NEW HAMPSHIRE
Representatives in principal cities.

New Materials and Equipment

ing. It will weld over itself and more ferrous materials without cracking, checking or porosity—a fact which permits patching where previously full replacement has been necessary.



New Tool Measures Temperature of Small Areas

A new high-speed small-target Rayotube, which is said to permit direct temperature measurements of visible work heated by most high frequency induction machines, where speed of response must be fast, and available target area is extremely small, has been announced by *Leeds & Northrup Co.*, 4901 Stenton Ave., Philadelphia 44.

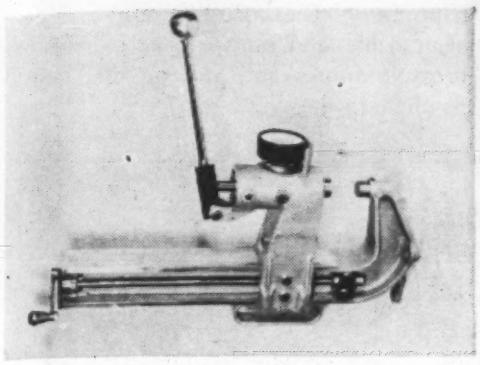
The new tool can measure temperatures from 800 F up. Mounted 4 in. from the induction coil, it can focus on an opening as small as 0.1 in. between turns of the coil and through this opening sight on the hot surfaces of the work. Its housing can withstand surrounding air temperatures up to 350 F. When suddenly exposed to radiation of a work piece, the Rayotube will indicate 99% of true temperature within 0.6 sec. If temperature of the work is changing, the temperature indicated by the Rayotube detector lags only 0.15 sec behind that of the work. And, finally, its optical system is hermetically sealed against dirt, dust and corrosive fumes.

The minute changes in radiation detected by the tool are transmitted to a Speedomax electronic recorder in the form of electrical millivoltage. This small electric current is amplified by the Speedomax instrument and automatically recorded on a chart calibrated in temperature degrees. When desired, this instrument — the Speedomax — can also automatically control temperatures by turning off current

(*Continued on page 153*)

New Materials and Equipment

when temperature reaches a predetermined point or by positioning a rheostat to control power output of a generator or the speed of a moving conveyor carrying parts through the inductor.



Portable Hardness Tester Features Greater Versatility

A new Brinell hardness tester, which is said to incorporate many new and distinct features never before offered in portable type testers, is currently being offered by *Blosjo Enterprises,* 5310 Golden Valley Rd., Minneapolis 22. The tester is designed for a hardness range of 20 to 500 Brinell, with maximum accuracy over the full range of the 12-in. gap and 4½-in. throat. The instrument is light, only 19 lb; yet it is claimed to be rugged for portable shop use, and to operate accurately in any position.

A new penetrator design requiring only 500 Kg of force greatly reduces the stress and strain on the instrument. Another exclusive feature is the protected impression. The part to be tested is actually clamped between the cylinder body and anvil, thus allowing the penetrator to be forced into and retracted from the work. The result is said to be a perfect unmarred impression.

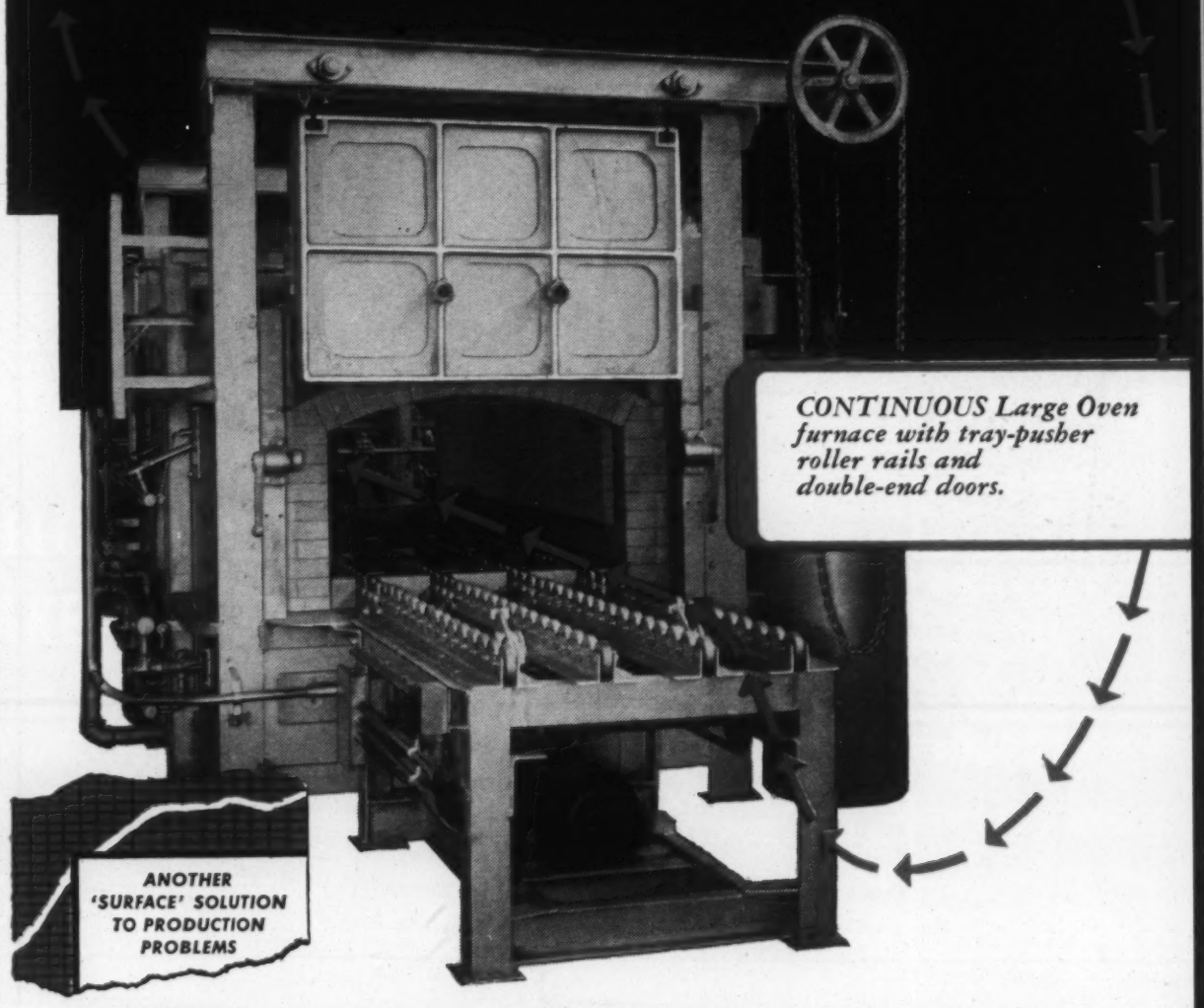
The test is positive—an impression being produced with a controlled hydraulic force, the impression read with a standard Brinell microscope, and translated to Brinell hardness.

Acid Cleaner for Ferrous Metals

Klem Chemicals, Inc., 14401 Lanson, Dearborn, Mich., has announced a phosphoric acid cleaner in concentrate form

Surface

CONTINUOUS PRODUCTION FOR SMALL INVESTMENT!



CONTINUOUS Large Oven furnace with tray-pusher roller rails and double-end doors.

ANOTHER 'SURFACE' SOLUTION TO PRODUCTION PROBLEMS

'Surface' direct-fired Large Oven furnaces, with pusher mechanism and double-end doors, deliver high production on an economical, continuous basis with relatively low investment.

Fully Automatic operation is possible by interlocking air-operated double-end doors, pusher mechanism and temperature controls.

Semi-Automatic operation can be attained by manual operation of pusher mechanism and doors. Variations involving both manual and automatic operation are possible where production requires.

Versatile: All major heat treat processes can be carried out on both ferrous and non-ferrous metals. Temperature range: 600 to 1800° F. Units up to 40 feet in length now in operation. *Call in a 'Surface' engineer or write today for full information.*

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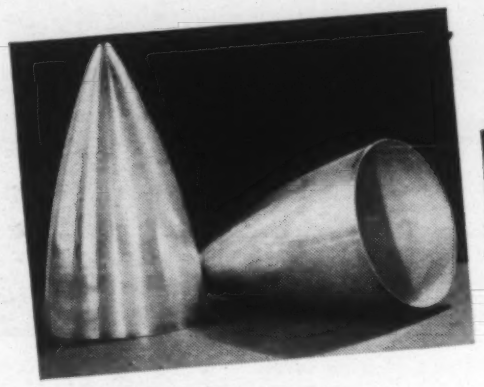
By Means of *Phoenixspun* Processing



Tail Piece —

The Problem: To produce 50 units on temporary tools, for a military application — short-term delivery demanded. Piece formed from a flat bank. Due to bullet shape, the exceptional depth presented a difficult forming problem, with the depth of draw approximately 18" and a diameter of approximately 9". Produced in four weeks, including tooling, compared with four months for the deep-draw process. Low cost wood tools used for a majority of the five operations accounted for this extra speedy production.

Drawn Housing —

The Problem: Producing 1000 units per month, 7½" diameter by 5" deep, from 18 gauge steel. Piece was originally formed by the spinning process. After production was converted to deep drawing, unit labor costs on the job were reduced from 15 hours to only 1½ hours per 100 pieces, at the same time quickly amortizing the higher tool cost required for deep drawing.

WHETHER or not your particular forming needs conform to either of these examples of PHOENIXSPUN adaptability, it is more than probable that our engineers can show you ways and means to simplify and reduce production costs. Your prints and specifications will bring prompt recommendations and estimates from our engineering staff.

METAL SPINNING
(Up to 108")
DEEP DRAWING
(To 350 Tons)
WELDING
—(Inert Gas Arc, Oxy-Acetylene)
FABRICATING

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For Product Designers

Metal Spinning Div., PHOENIX PRODUCTS CO.

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New Materials and Equipment

for ferrous metals. Designated as Rust-Sol #123, this cleaner can be applied either by brush-on or immersion method, and rinsed off with clear water.

The cleaner is said to dissolve all surface rust, salts and scale from production pieces, and to neutralize and activate the surface with a slight etch and iron phosphate coating, which makes an excellent base for paint.

Because of its neutralizing action, the cleaner can also be used following alkali stripping or cleaning. It is nontoxic, noninflammable and nonvolatile. It emits no corrosive fumes and can be used safely anywhere in the plant.

Redesigned 300-Amp A. C. Welder Announced

A redesigned 300-amp a.c. welding transformer, featuring stepless current selection from 40 to 375 amp, has been announced by the Welding Dept., *General Electric Co.*, Schenectady 5, N. Y. The new unit, for practically all applications from light-duty, low-current sheet metal work to heavier-duty, high-current industrial jobs, incorporates an enlarged scale and finely threaded screw adjustment to facilitate easy current selections. It accommodates electrodes from 3/32- to ¼-in. dia, and has a handy range switch which enables the operator to change quickly from high to low, or low to high range.

Arc-stabilizing capacitors in the redesigned equipment are said to contribute toward increased production by enabling

A Ringing Success . . .

SHARON* DEVELOPED SPECIAL STEEL MAKES TELEPHONE BELLS RING TRUE

Shortages of critical materials often force the use of substitutions. This happened in the telephone industry, where recently a manufacturer of phone bells — cut off from his supply of copper and brass—began looking for a suitable replacement.

Steel was still on the unrationed list, but bells formed of available steel didn't produce the required ringing tone. That is until Sharon Steel was asked to develop a steel of a temper that could be formed into bells with the required tone.

Sharon engineers went to work and in a short time developed a steel that fills the bill so effectively it is expected to become standard regardless of the availability of the materials formerly used.

***Specialists in STAINLESS, ALLOY, COLD ROLLED and COATED Strip Steels.**

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Sharon, Pennsylvania

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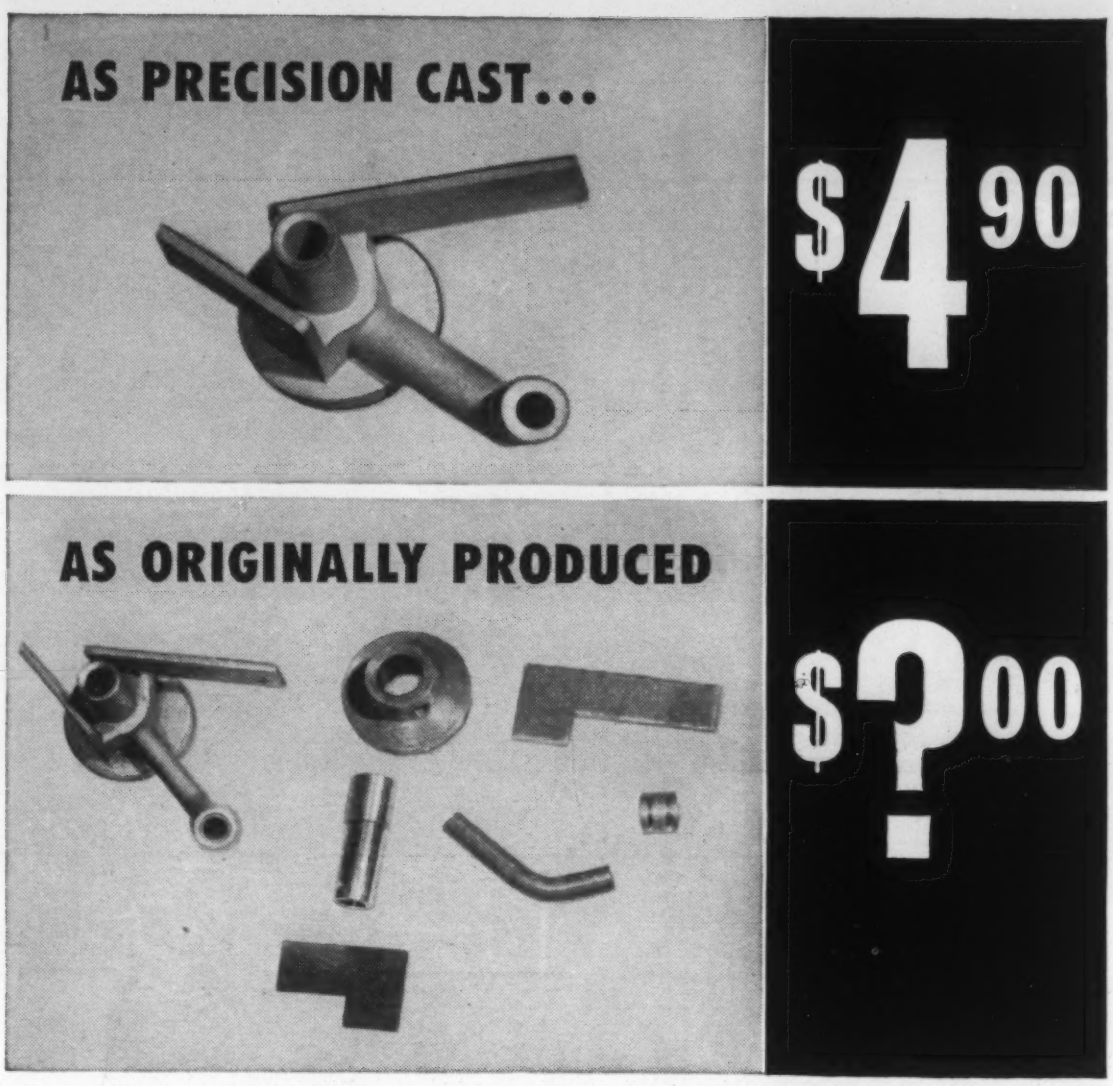
For information on Titanium contact Mallory-Sharon Titanium Corp., Niles, Ohio

SHARONSTEEL



Precision Metalsmiths casts this valve as a pressure-tight unit in a beryllium copper alloy at the unbelievably low cost of $4.90.

Figure what it would cost—at your overhead—to produce, handle and stock the six brass, copper and steel parts that formerly went into this assembly. Then add fabrication costs, with an allowance for leaker-rejects that showed up all too frequently.

We can't promise you savings like this, of course. But the expendable pattern process gives product designers a free rein; your men *imagine* what they'd like to have and we cast it for them. Many machining and assembly operations can be eliminated and, often, parts are made in alloys that can't be machined—a fraction of an ounce up to 10 pounds.

Say "when"

you're worried about high costs

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PRECISION METALSMITHS, INC., 1077 East 200th St., Cleveland 17, Ohio

pour yourself an assembly with

PRECISION METALSMITHS INC.

INVESTMENT CASTINGS

New Materials and Equipment

the operator to strike and maintain an arc without pop outs. Extra protection against high temperature coil failure is provided by silicone insulation, a resin which retains its mechanical and electrical strength at high temperatures. To further protect the coils from hotspots, they are ventilated by a forced-draft fan rated for continuous duty.

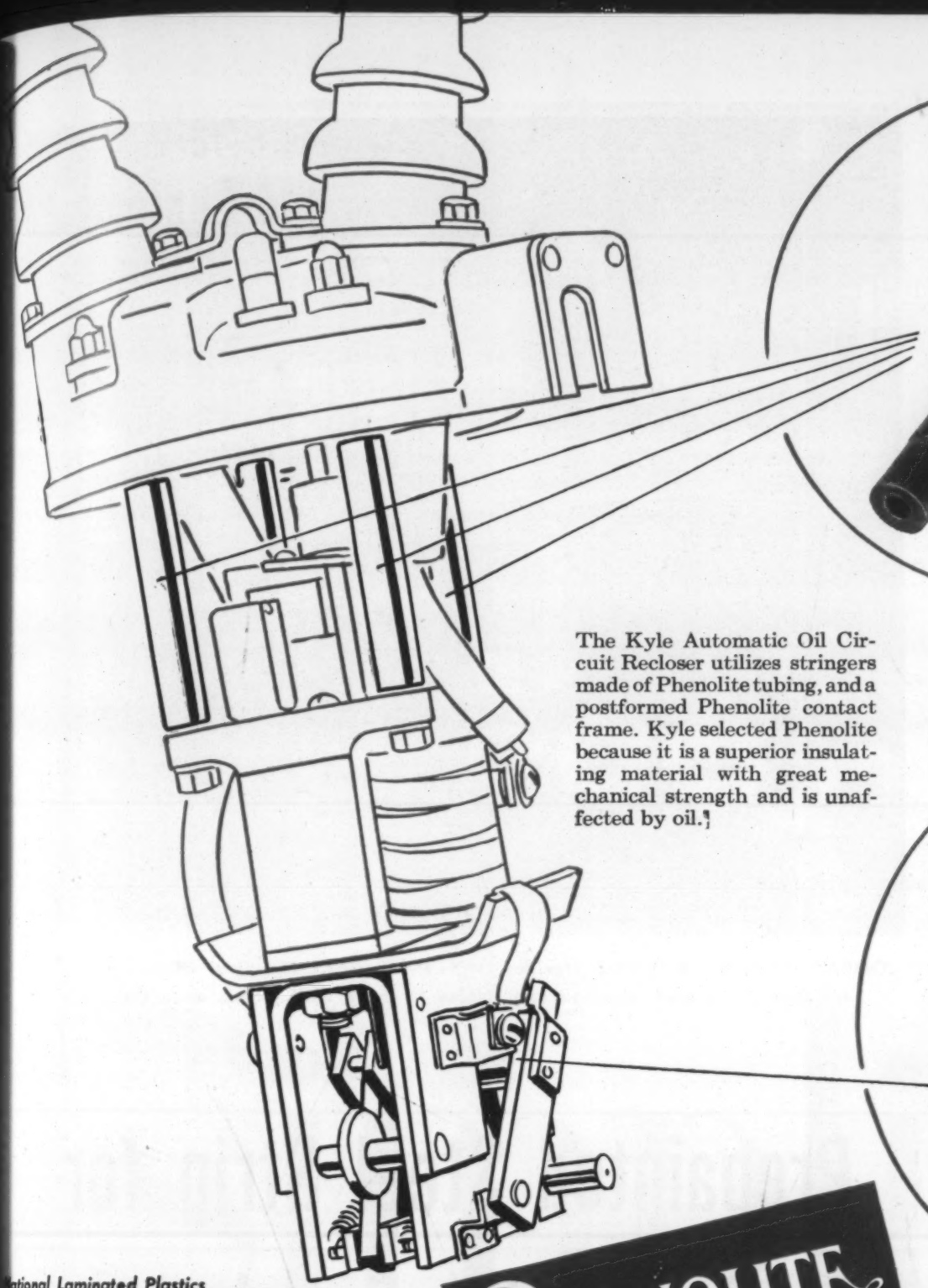
The welder is built with studs at the base to simplify connecting electrode and work cables. Power-factor-correction capacitors assure low power costs. The unit is 36 in. high, 21 in. in dia, and weighs approximately 328 lb.

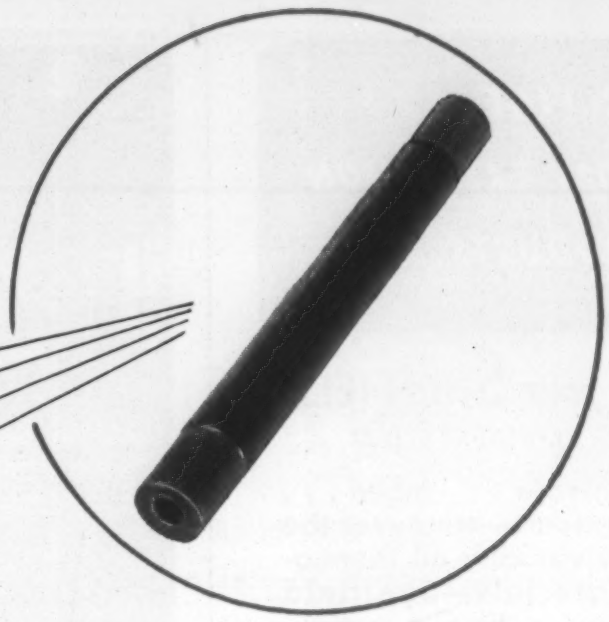
Cleaning Compound Prepares Aluminum for Welding

A new process, used in preparing aluminum surfaces for welding, has been announced by *Northwest Chemical Co.*, 9310 Roselawn, Detroit. According to the company, the new process thoroughly removes all oils and oxidizes, without harming the metal, thereby reducing surface resistance to a value of 0 to 10 microhms. The company also adds that a resistance of 10 to 20 microhms will persist for many days without reoxidation.

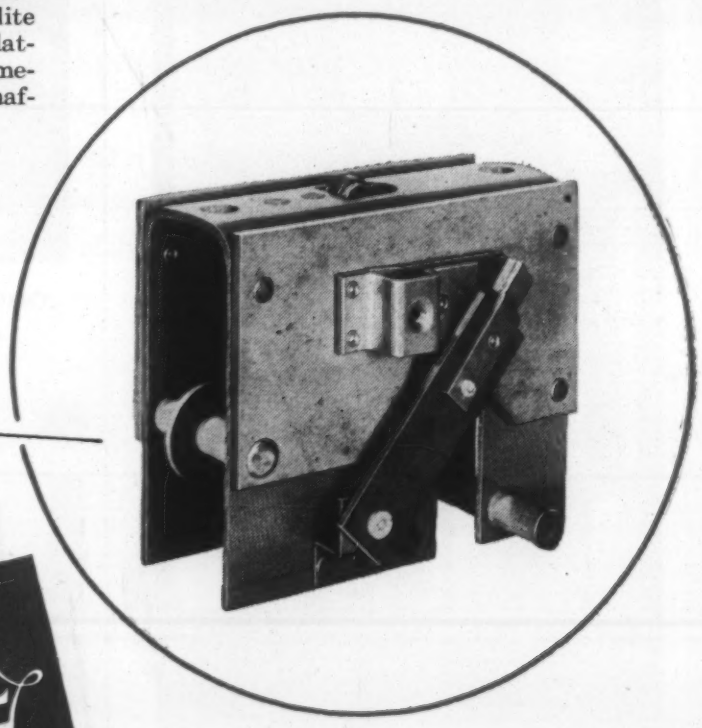
In addition to eliminating mechanical cleaning operations such as the use of rotary wire brushes, the method is said to assure more perfectly formed welds, free from cracks, at a worthwhile saving in time and cost.

Laboratory tests made on various alloys and gages of metal indicate that the process allows for production welds meeting specified values for penetration and shear strength. Welds also average well above allowable deviation in shear strength. Tests indicate conclusively that more welds are possible between tip dressings, and at lower pressures.





The Kyle Automatic Oil Circuit Recloser utilizes stringers made of Phenolite tubing, and a postformed Phenolite contact frame. Kyle selected Phenolite because it is a superior insulating material with great mechanical strength and is unaffected by oil.



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National Laminated Plastics
Nationally known—nationally accepted

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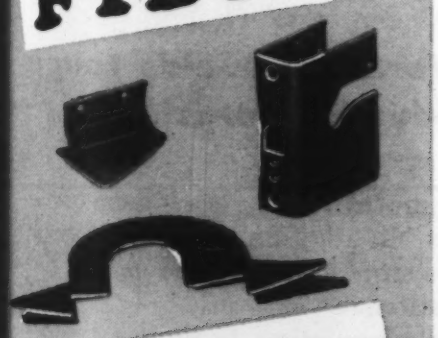

PHENOLITE Laminated PLASTIC

contributes to an improved product— in the Kyle Automatic Oil Circuit Recloser

This practical use of Phenolite by the Kyle Products Plant of the Line Material Company is typical of its countless applications in the electrical field. Phenolite, about one-half the weight of aluminum, is the perfect insulating material for high and low voltage applications. It possesses an unusual combination of properties. Phenolite has great mechanical strength and high resistance to moisture; ready machinability; is unaffected by solvents and oils.

It can be easily punched, sawed and sheared. The toughness and high impact strength of cloth base Phenolite sheet make it suitable for gears; it is one of the strongest materials per unit weight known.

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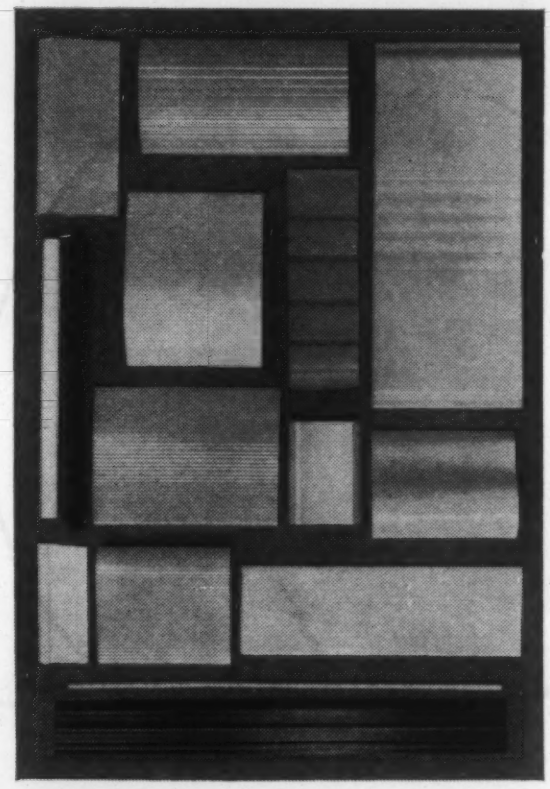

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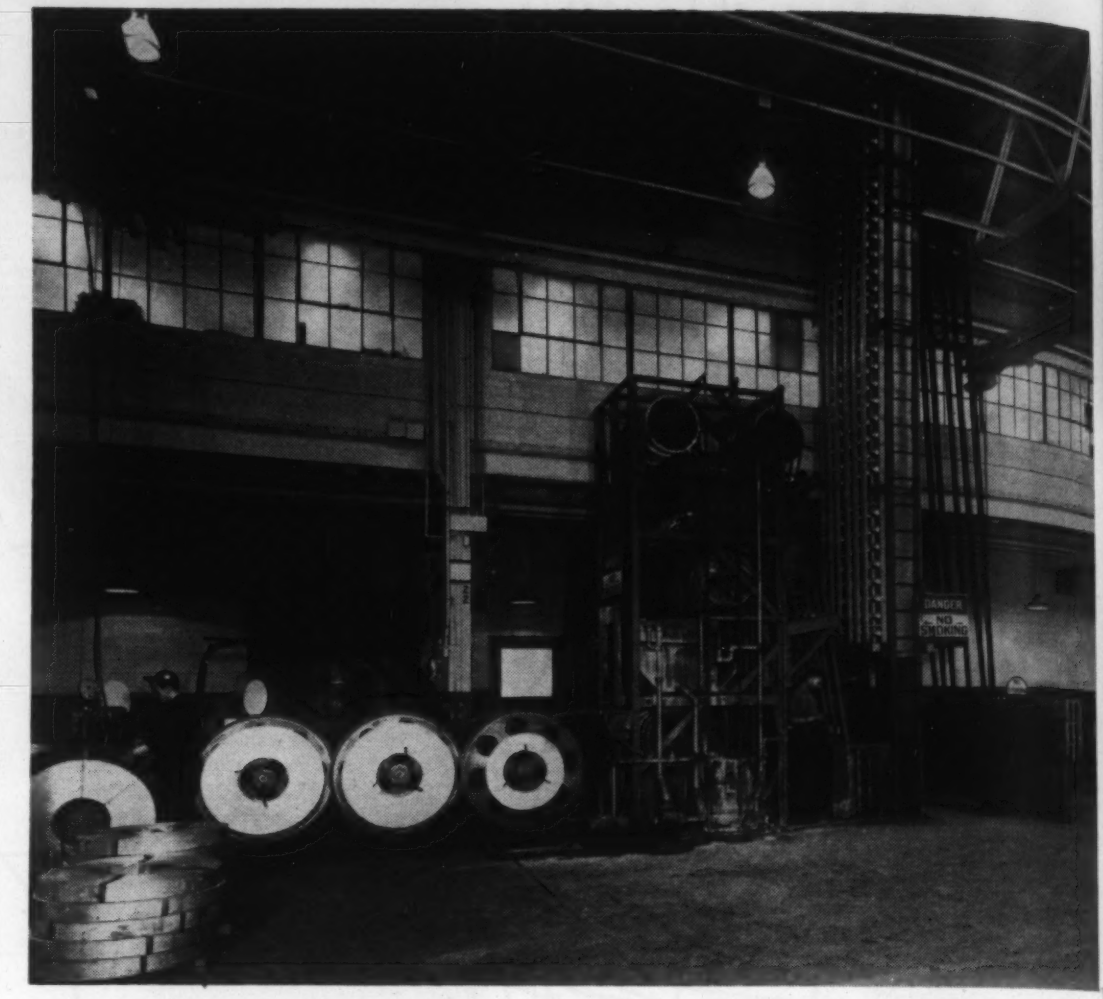


COMPACT COATING MACHINE provides corrosion resistant steel strip which can later be roll-formed, sheared, punched and riveted to make wall plates, door slats, etc.

Prepainted Steel Strip for Production Forming

by **KENNETH ROSE**, Mid-Western Editor, Materials & Methods

Continuous enameling prior to forming avoids tough finishing problems, keeps production rates high.

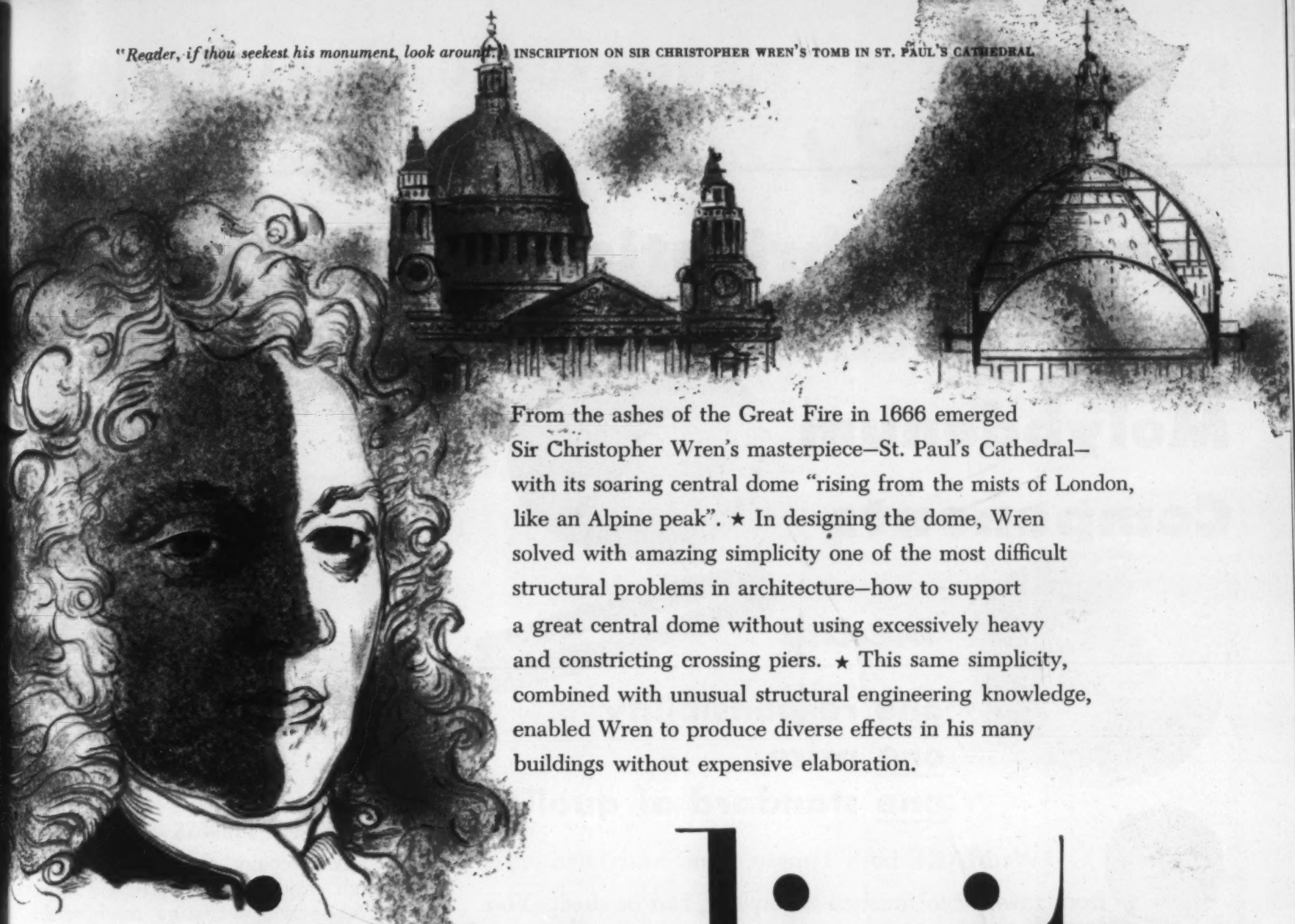
● PAINTING A formed steel part with a coat thick and uniform enough to prevent corrosion — and doing it at mass production speeds—would be a difficult job.

The best way around such a job, R. C. Mahon Co. found, is to prepaint the steel strip *prior* to cold forming operations. Their production of slats for rolling steel doors, steel deck plates and interlocking plates for metal walls is now being handled in this manner. Painting procedures are greatly simplified and complete coverage of the piece is assured, even when the form involves deep, narrow grooves or nearly closed curved shapes. In addition, prepainted stock can be stored without danger of deterioration.

The prepainting technique would be impractical, of course, if machining, hot forming or welding were to follow. But these parts require only roll forming from coils, shearing to length, punching rivet holes and riveting. The steel, purchased in coils, is SAE 1020 strip in 18- to 20-gage thicknesses and in widths ranging approximately from 12 to 18½ in.

(*Continued on page 160*)

"Reader, if thou seekest his monument, look around." INSCRIPTION ON SIR CHRISTOPHER WREN'S TOMB IN ST. PAUL'S CATHEDRAL



From the ashes of the Great Fire in 1666 emerged Sir Christopher Wren's masterpiece—St. Paul's Cathedral—with its soaring central dome "rising from the mists of London, like an Alpine peak". ★ In designing the dome, Wren solved with amazing simplicity one of the most difficult structural problems in architecture—how to support a great central dome without using excessively heavy and constricting crossing piers. ★ This same simplicity, combined with unusual structural engineering knowledge, enabled Wren to produce diverse effects in his many buildings without expensive elaboration.

simplicity

Whether hidden from sight doing a functional job, or exposed to view just looking pretty, Van Huffel metal shapes and tubing simplify a lot of today's building problems. ★ Architects, designers and engineers know they can incorporate in their designs strength without cessive weight . . . economy without sacrificing quality . . . and simplicity without complicated assembly. That's why they are continually thinking up new uses. That, too, is why they keep coming to Van Huffel —where ideas take shape—in metal.

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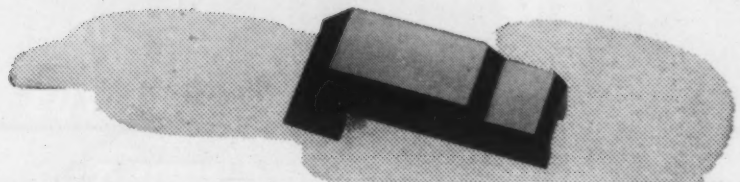

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Fansteel Metallurgical Corporation NORTH CHICAGO, ILLINOIS, U.S.A.

Prepainted Steel Strip . . . .

continued from page 158

***VERTICAL BAKING OVEN** saves valuable floor space.*

Continuous Process

To prepaint the steel strip at a high production rate, R. C. Mahon Co. devised a coating machine that conveys the steel from a feed coil through (1) a bath containing an alkaline cleaning and degreasing solution, (2) a bath containing a phosphate solution, and (3) a bath containing a chromic acid solution. Next, the air-dried strip is carried into a bath containing a rust-inhibiting synthetic enamel, held at a slightly elevated temperature to provide the proper viscosity for complete coverage and quick draining. The coated strip travels through a tunnel-type baking oven, where the enamel coat sets up. The emerging painted strip is then dry and ready to be rewound onto a coil.

The coils of painted strip stock are taken to the forming areas, where continuous roll formers shape them as they are unwound and fed through the machines. If not needed at the forming areas immediately, the prepainted coils can be moved to storage.

The flow of material through the coating machine is made continuous by spotwelding the end of each coil to the lead of the next coil. As the take-up coil fills, the stock is cut off and winding onto a new coil begins. No attempt is made to grind these joinings flush; instead, they are cut out and discarded as the strip goes through the forming rolls.

(*Continued on page 162*)

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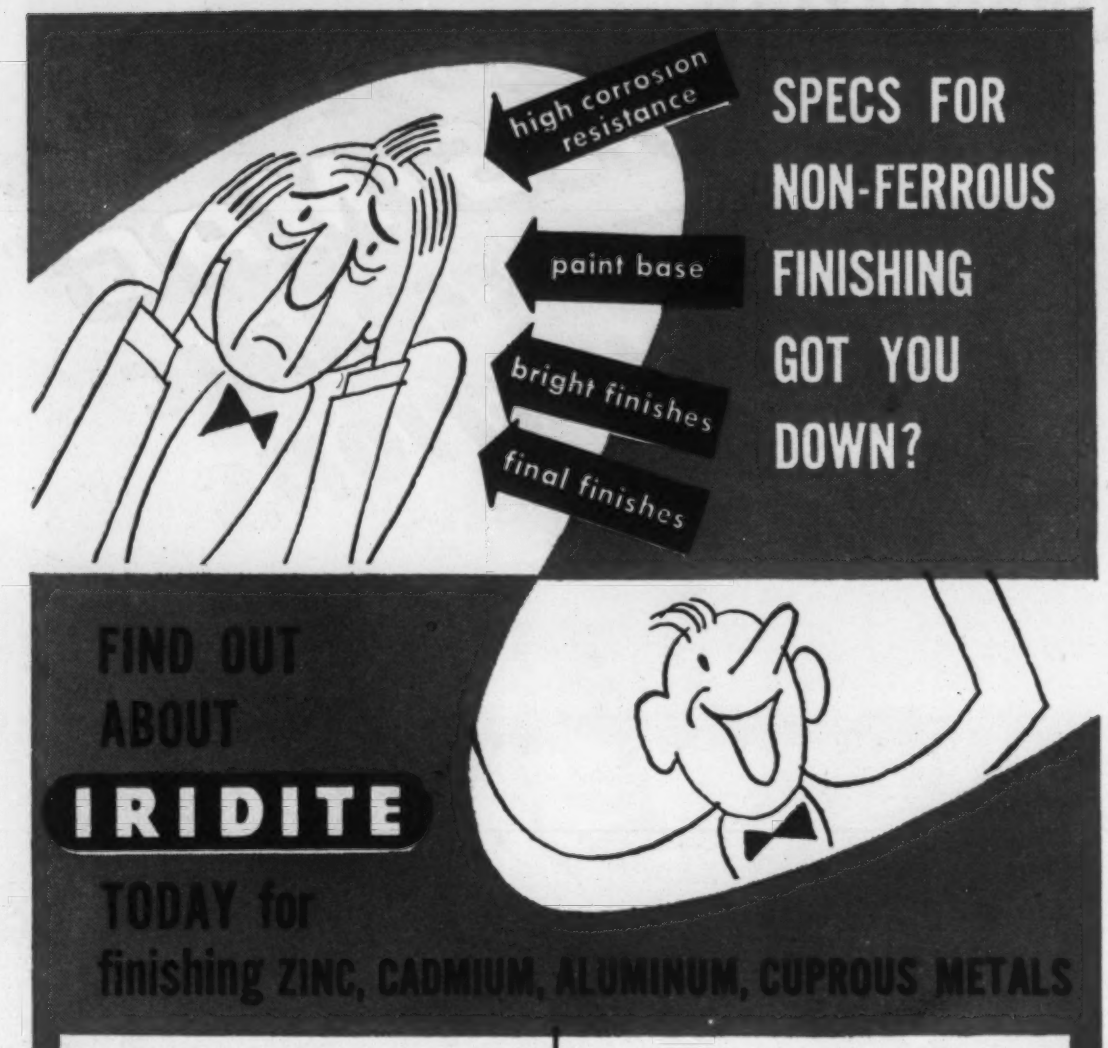
continued from page 160

Compact Arrangement

The steel strip travels through the machine at the rate of about 12 ft per min. Each machine processes several coils simultaneously, the number depending upon the width of the stock. The wider strip is fed through four coils at a time, while the 12-in. steel is painted six coils at a time.

An unusual arrangement of the baths and tunnel in the painting machine makes it possible to locate the entire painting system, exclusive of the steel coils, within about 10 ft of floor length. The strip from the feed coil runs over an idler pulley, then vertically into a short, narrow, but deep tank, around another pulley near the bottom of the tank, and up and out of the tank to another pulley. This is repeated for the succeeding baths, including the paint bath. In this way most of the travel of the stock through the baths is vertical.

The baking tunnel uses the same principle. It is built in the form of a rectangular tower, about 50 ft high, extending through the roof of the building. The strip travels to the top of the oven, over a pulley, and leaves the oven through a heat seal to return to floor level outside the oven itself. In one of the prepainting machines, baking is done by banks of infra-red lamps. The other prepainting machine uses batteries of gas burners.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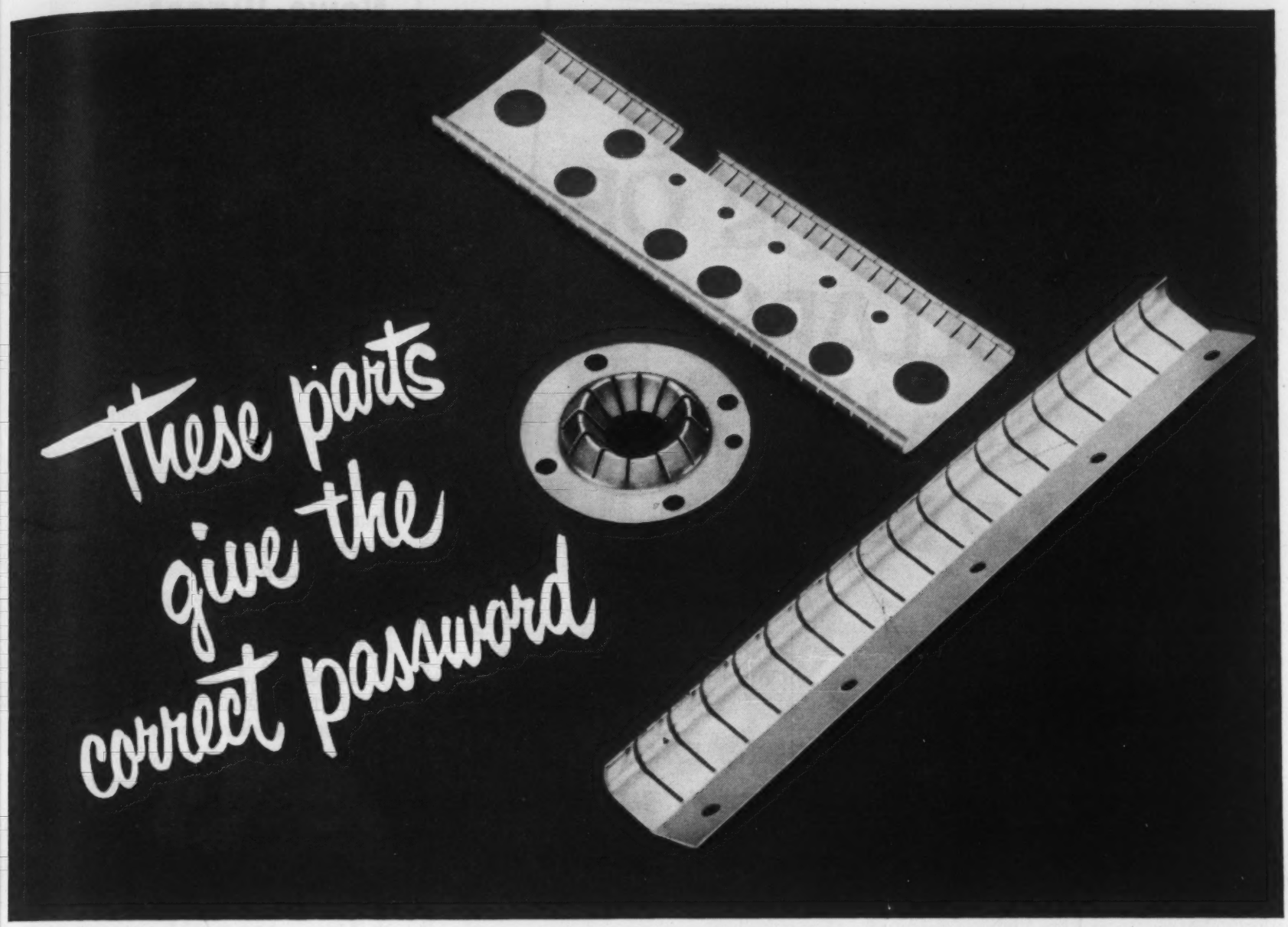

Parts shown processed by H. Braun Tool & Instrument Co., Hawthorne, N.J.

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If the IFF radar device used by aircraft should give the wrong signal, our own planes would be in danger of being shot down by antiaircraft and fighter interceptors. Small but vital beryllium copper parts prevent any such catastrophe.

To insure the correct signal, each finger in the circular part must have uniform tension and must line up perfectly. That's one reason why beryllium copper was chosen for this application. The required accuracy can be achieved only by fixture heat treating, and Berylco is the only material that can stand such severe forming and still retain its desirable spring properties.

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The ability of Berylco to offer the designer more than one desirable property has materially increased its application—for peacetime products as well as those used in defense. If you would like to include Berylco in your plans for the future, we invite you to share the knowledge of the world's largest producer of beryllium copper. Call or write any of the offices listed below for help or sample material.

THE MOST COMPLETE LISTING of available beryllium copper forms is contained in the Berylco *Product Directory*, just published. Send for your free copy today.

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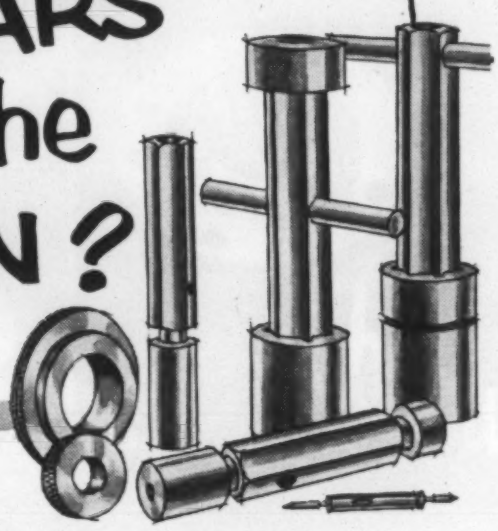

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This compact new chrome plating unit is saving real money for leading engineering and manufacturing concerns throughout the country. For instance, here's what Taller and Cooper, Inc., foremost makers of toll collection equipment and builders of electro-mechanical measuring and recording devices, say about their Chromaster installation:

> "Within one hour from the time a space was arranged for the unit, the Chromaster was in operation. In the very first day over $100.00 worth of undersize plug gages that normally would have been discarded were replated and put back in use in our inspection department."

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Model A-20 (shown here) is a 20-amp, bench-mounted unit for the gage room or tool crib; plates up to 10 sq. in.

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News Digest

continued from page 8

aluminum and stainless steel. Titanium producers are counting on their metal to fill this gap.

Metallurgy and Production

Another indication that still better titanium alloys may be in the offing was given by M. Hansen and H. D. Kessler, who reported some preliminary results of work in progress at the Armour Research Foundation.

Among the alloys being studied there are some having "excellent properties up to 1020 F". According to these authors, some of the alloys show better creep rupture properties at this temperature than types 304 and 403 stainless steel.

Hansen and Kessler believe that titanium metallurgy is "in the ideal position of developing concurrently or even in advance of industrial practice". They think the important physical metallurgical information on phase diagrams and transformation kinetics being developed should help bring about the development of optimum alloys for various applications in the shortest possible time.

Titanium Forgeability

Complaints from some forging shops working with titanium have been cited as an important deterrent to its wide use. A more optimistic view of the forgeability characteristics of present-day titanium alloys was taken by L. R. Frazier of General Electric Co.

"We cannot deny that there are many problems peculiar to forging titanium," he admitted.

But he added: "When forging organizations have obtained further experience with titanium alloys and have adequate technical staff to control the wayward tendencies of this juvenile metal, they find the titanium alloys suitable for forging. Nearly any shape that can be forged in steel can likewise be forged in titanium by practical means."

References to several specific applications of titanium in aircraft engine forgings were made by Frazier.

Among the high strength alloys, he singled out the 3 aluminum-5% chromium commercial alloy which he thinks would prove most useful in nonrotating forged parts requiring yield strengths on the order of 160,000 psi—landing gear forgings, for

(Advertisement)

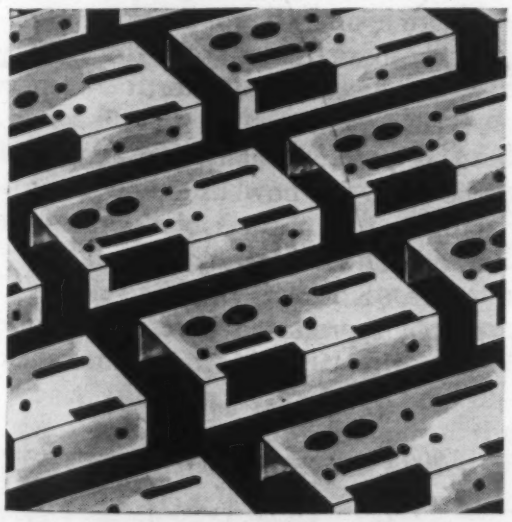
Fingerprints and Water Stains On Copper Plate Prevented by Water Dip Treatment

The common problem of fingerprinting, water staining and oxidation on copper-plated surfaces has been effectively solved by the use of Water Dip #33 for applying a protective coating to the copper plate.

This treatment is extremely economical, since the work goes directly from the hot water rinse into the Water Dip tank, without any need for intermediate drying and rehandling.

Speeds up soldering

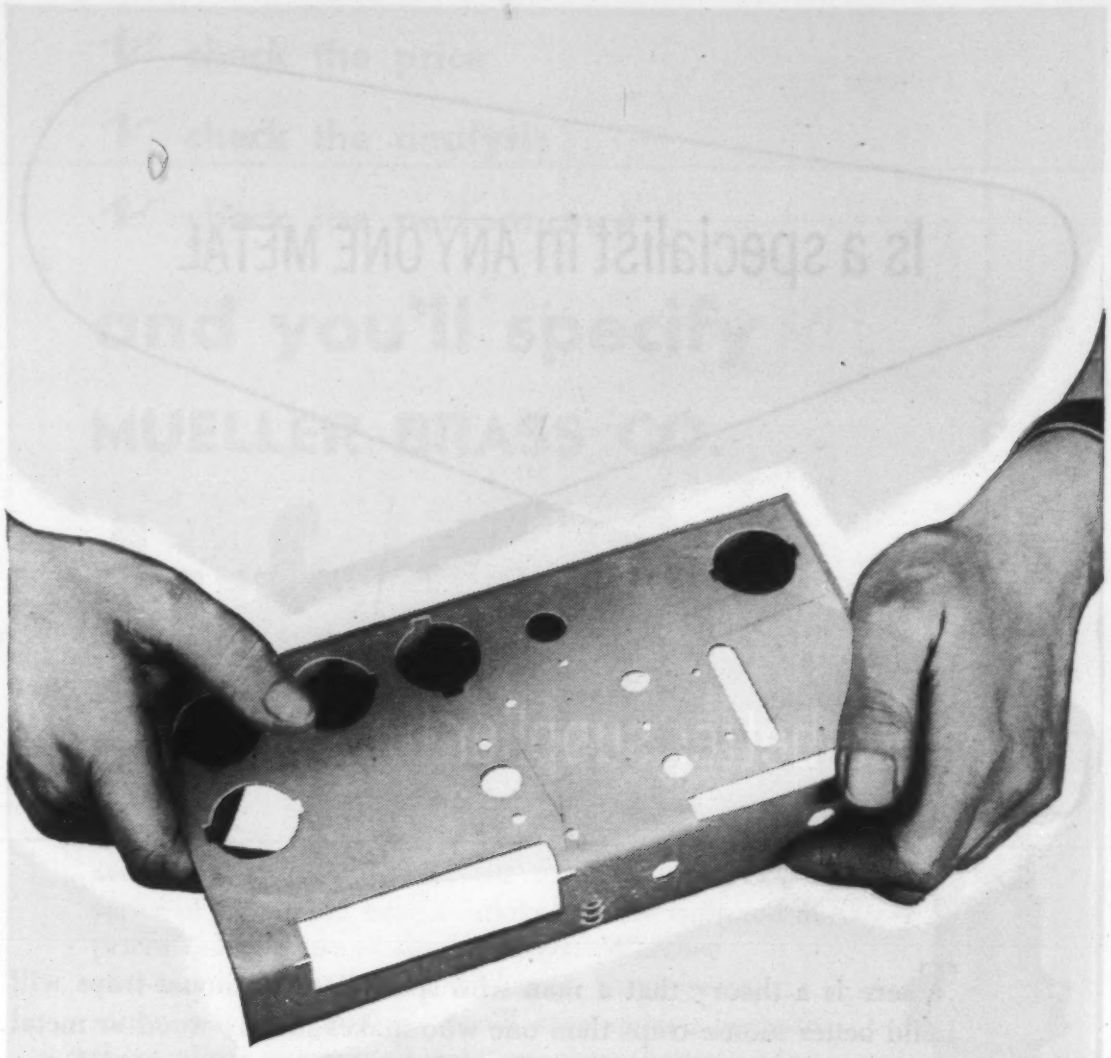
Application of Water Dip #33 not only does not interfere with subsequent soldering, as in the wiring of radio chassis, but actually improves and speeds up the operation. The coating prevents the usual formation of metal oxides while parts are in storage prior to wiring, and in most cases the electrical resistance of Water Dip #33 is no higher than the oxides would offer.



5000 radio chassis were copper-plated by one manufacturer and dipped in Water Dip #33. There were no rejects after riveting and soldering operations.

Less risk of error

While Water Dip #33 is colorless as supplied, dyes can readily be added for identification of terminals or other parts. This gives quick visual identification that simplifies the job of connecting wires to the right terminal, and saves insepction time. Water Dip #33 is produced by Maas & Waldstein Company, Newark 4, N. J., and is described in Technical Data Bulletin #117, available from the manufacturer.



Copper-plated Parts Stay Bright and Clean

when the plating shop treats them with WATER DIP #33

Then you'll want the full story on a simple, low-cost metal treatment that *keeps* the copper surface bright and chemically clean—just as it comes from the plating bath. *M & W Water Dip # 33 prevents finger printing and staining during assembly, storage and use.*

If you're doing copper plating, you can cut out extra operations by using Water Dip #33. Work goes *directly* from the last hot water rinse into Water Dip #33—no need for rehandling and drying!

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Others say, "Specialists are those who know more and more about less and less," which invites the conclusion that the greatest specialist of all must be he who knows everything about nothing.

Federated believes that the hundreds of products of non-ferrous origin have a basic family resemblance, and that the more we know about all, the more we know about each. Thus lead is found with silver and antimony, and copper and tin are found with iron. These various elements and others must be separated and refined, or in some cases, discarded. Then, re-combined in different ways, sometimes alone, sometimes with other non-ferrous ingredients, they make brass, bronze and aluminum ingot; solders and type metals; die casting alloys, lead products and bearing metals; anodes for plating and for cathodic protection.

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News Digest

example. He also sees possible use of this alloy for pinions, gears, splines and other moving parts which have some sliding motion at the surface, provided a suitable surface hardening procedure for titanium can be developed.

One important application for low strength alloys is forgings which are to be welded to sheet metal parts, inasmuch as high strength titanium alloys are not suitable for welding. Bearing housings, which generally require rather intricate machining and some precision grinding, represent another suitable application for low strength alloys.

The great bulk of titanium alloy forgings utilize the medium strength alloys, which have a better balance of properties than the low or high strength compositions. All three groups, however, possess about equal forgeability, according to Frazier. All must be heated in limited time to prevent formation of a hard, brittle crust under the scale, and all are subject to surface imperfections which must be removed before finish forging.

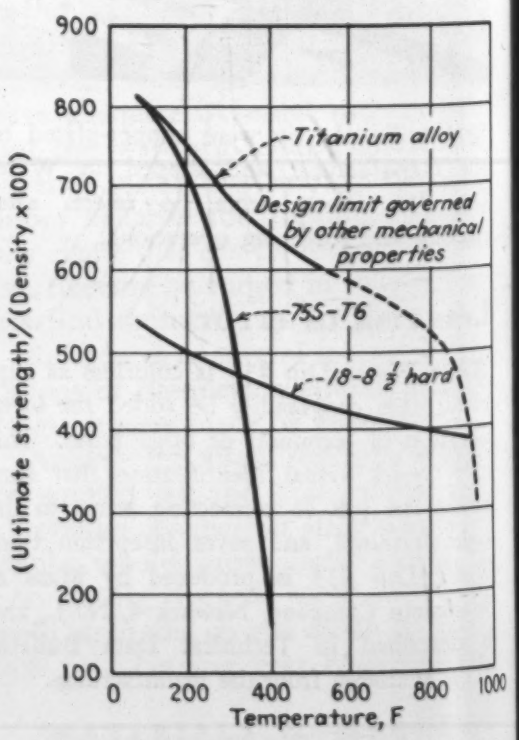
Titanium for Airframes

Other aircraft applications, particularly in airframes, were discussed by F. R. Kostoch of North American Aviation, Inc.

He pointed out that one model of the F-86 jet now uses 600 lb of titanium, an appreciable part of the fighter's total airframe weight.

Mr. Kostoch used a simplified graph, reproduced here, to illustrate why aircraft design engineers are

(Continued on page 169)



turning to titanium. The figure shows the change in strength-weight ratios of a titanium alloy, a high strength aluminum alloy and ½-hard 18:8 stainless steel as the temperature rises.

It is evident that between 250 and 800 F, titanium offers advantages over both competing materials. Just as jet engine designers find titanium a necessity in coping with gas temperatures, so the airframe designer finds both pure titanium and its alloys invaluable in the design of the airframe adjacent to the jet, namely the aft fuselage section. The pure titanium is used for firewalls and other heat shields where strength is not as important as corrosion resistance.

The foreseeable future holds still another temperature problem for the airframe designer: that resulting from air-skin friction at high speeds. According to Kostoch, the calculated skin temperature at a speed of Mach 2 and altitude of 35,000 ft approaches 600 F. This is about the absolute limit of current high strength aluminum alloys, and Kostoch predicts that as airplanes go faster the area of titanium use will expand to the forward fuselage and wings.

In addition to these applications where use of titanium is mandatory, the author pointed out that there are many places in the current airframe designs where titanium could be used to advantage when its cost comes down.

As a possible antidote to some of the more generalized statements on the corrosion resistance of titanium, W. L. Williams of the U. S. Naval Engineering Experiment Station undertook a careful examination of the galvanic corrosion charactertistics of titanium. His conclusion was that although titanium is cathodic to most of the common constructional materials, the galvanic corrosion problems associated with its use are not different from the problems encountered with such well-known alloys as monel and stainless steel.

Need Transparent Materials

Evidence that today's aircraft design problems are not confined to the engine and airframe was given by G. E. Hughes of Boeing Airplane Co.

He asserted that "the aircraft industry is in a position of being seriously hampered for lack of adequate transparent materials for piloted aircraft unless continued pressure is

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✓ check the performance

and you'll specify

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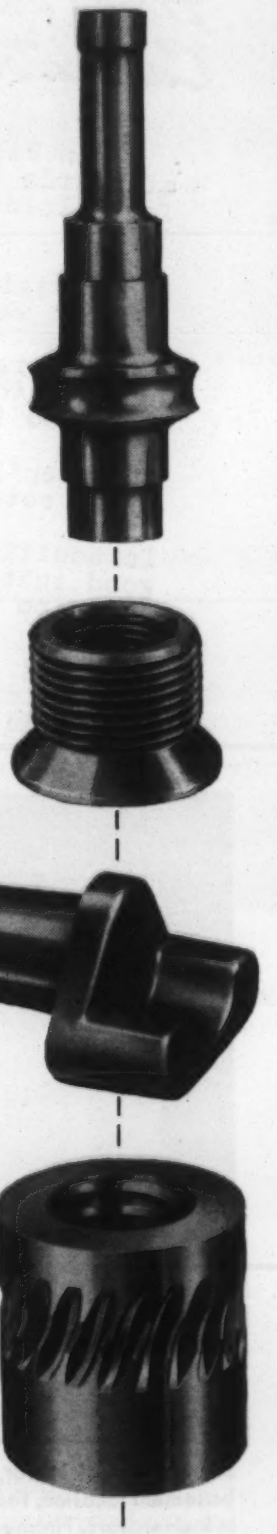

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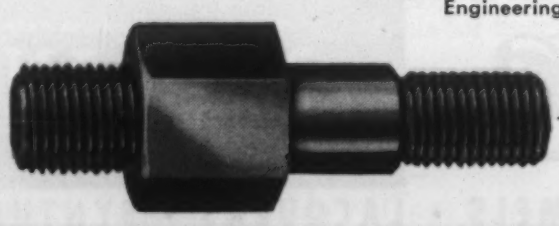

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placed on the development of still better transparent materials . . ."

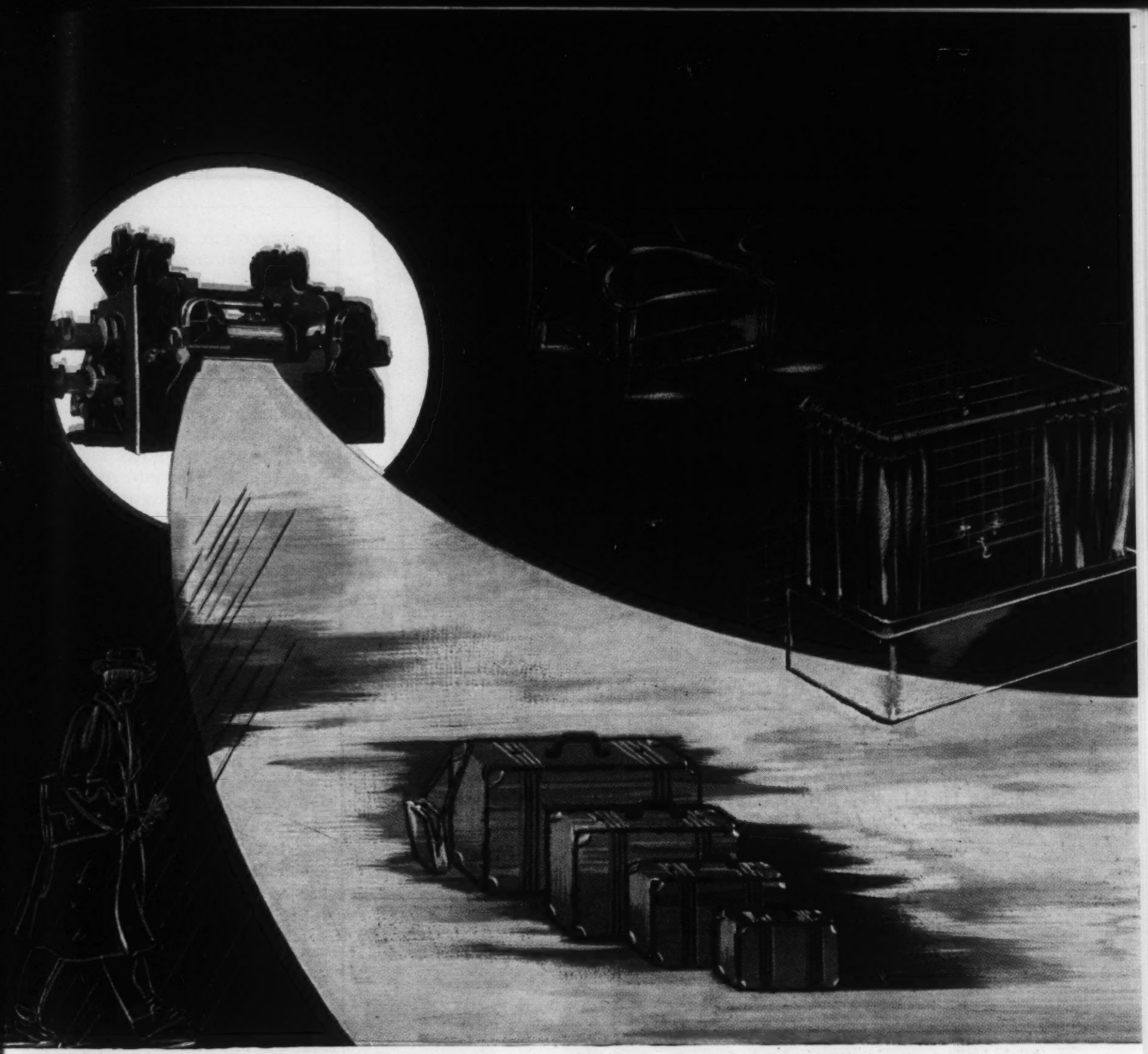
In the years since World War II, the aircraft industry has concentrated mainly on two transparent plastics for aircraft enclosures: a laminated methyl methacrylate with polyvinyl butyral interlayer, and a monolithic nonplasticized methyl methacrylate. Both materials have been subject to crazing and have caused high replacement rates.

Three years ago, according to Hughes, the industry awoke to the fact that it was sadly lacking a transparent material in keeping with the pace of aircraft design. A material which was barely satisfactory at present could not hope to serve as speeds and temperatures increased.

Since then, the search for new materials has intensified. At the present time there are three types of materials upon which the industry is pinning its hopes. They are: a cross-linked acrylic, a polyester and polymethyl alphachloroacrylate.

The cross-linked acrylic consists of a large proportion of methyl methacrylate cross-linked chemically with a new material or materials to give improved properties. An example is Rohm & Haas' 5105XP compound. This material has better thermal stability and better craze resistance than the straight acrylic; it also has good light transmission characteristics and resists deterioration from aging. It can be formed readily into compound shapes. Since its heat resistance is only slightly better than that of methyl methacrylate, however, it appears that the cross-linked acrylic, though it offers advantages on present aircraft, will not satisfy future conditions.

Among the most promising polyesters is a material known as Sieraccin 611 (Sierra Products Co.) and Selectron 44 (Pittsburgh Plate Glass Co.). Outstanding property of these resins is their "apparent complete craze resistance" to both solvent and stress crazing. They are somewhat weaker than the regular acrylics in notch sensitivity, and their other properties, such as tensile strength and flexural strength, are within the range of the regular acrylics. Thermal resistance is in the range of the heat resistant acrylics. Forming characteristics are somewhat limited when compared with either the regular or cross-linked acrylics. Hughes believes this material has a definite place in existing aircraft and



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Remarkable new VR 21 is now available for volume consumption. Try it in your film and sheeting formulations and see how it provides *both* processability and product quality.

In addition to VR 21, Naugatuck's family of products includes a variety of other Marvinol® resins and compounds, as well as Vibrin® polyesters and Kralastic® resin-rubber blends —fine basic materials for finer plastic products.

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Fine particle size is an outstanding feature of MH Chrome Nickel alloy powders, as indicated on the chart below.

TABLE XIII

COMPARISON OF EFFECTS OF HEAT TREATMENT ON PROPERTIES OF ELECTROLYTIC IRON POWDER PLUS ALLOYS OF VARIED NICKEL—CHROMIUM CONTENTS

Compacting Pressure — 50 tsi
Sintering Condition — 1100 C for 1 hour at temperature in hydrogen

MATERIAL	Electrolytic Iron + 1% Graphite + 10% Alloy (80% Ni — 20% Cr) TENSILE STRENGTH PSI	ELONGATION %IN 1"	ROCKWELL HARDNESS	SINTERED DENSITY G CC	Electrolytic Iron + 1% Graphite + 10% Alloy (80% Cr — 20% Ni) TENSILE STRENGTH PSI	ELONGATION %IN 1"	ROCKWELL HARDNESS	SINTERED DENSITY G CC
Sintered	72200	2.5	R_B83	7.11	66100	2.0	R_B99	6.64
Coined	76300	4.6	R_B85	7.18	63000	2.0	R_B95	6.65
Coined & Annealed	71000	3.5	R_B84	7.15	83000	2.0	R_B95	6.65
Coined & Quenched	76900	1.7	R_C25	7.08	84400	2.0	R_B100	6.65
Coined, Quenched & Annealed	99500	0.5	R_C15	7.08	92900	2.0	R_B96	6.65
Quenched	75800	2.3	R_C19	7.11	84000	2.0	R_B97	6.65
Quenched & Annealed	88650	2.3	R_C16	7.11	77300	2.0	R_B95	6.65

Size Characteristics—(80% Ni — 20% Cr)

+100	2.4%
−100 + 200	31.9%
−200 + 325	28.5%
−325	37.2%

Size Characteristics—(80% Cr — 20% Ni)

−100 + 200	4.7
−200 + 325	9.7
−325	85.6

For detailed information, write:

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News Digest

in some future applications because of its excellent craze resistance. But, he concludes, "insufficient thermal resistance will probably limit its use on supersonic aircraft".

Of the three types of materials, polymethyl alphachloroacrylate seems to offer the most promise. Its outstanding property is its heat resistance —the heat distortion point being 250 to 270 F. It aslo has much better craze resistance than the regular acrylic and it has good solvent resistance. Its tensile and flexural strengths and its notch sensitivity are better than those of the regular acrylics. Main difficulty at the present time is supply. The material is being made by General Aniline and Film Corp. under the trade name of Gafite. Because of toxicity and handling difficulties, Hughes said, it will probably be some time before an ample supply is available for high production.

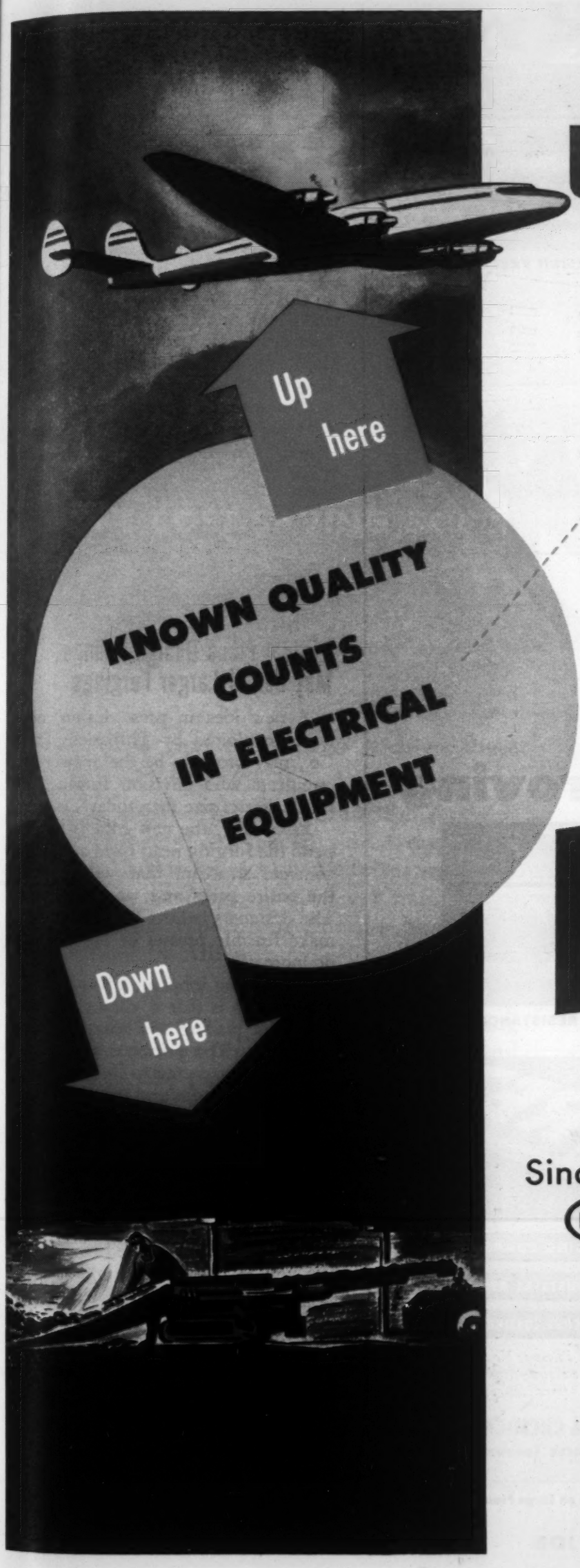
Glass has not been ignored in the search for transparent materials, Hughes pointed out, but laminated glass, which uses the polyvinyl butyral interlayer, has been outmoded by the same thermal barrier which restricts use of present-day plastics. Monolithic glass has good temperature resistance, but its notch sensitivity is a hazard. New attachment methods might some day make it applicable to supersonic aircraft.

The problem of new edge attachments is one that may be applicable to the new transparent plastics also. The trend in latest designs is away from glass fiber fabrics, toward other fabric laminates and Dacron, Orlon and nylon synthetic fibers. These materials have coefficients of expansion closer to those of the plastics than do the glass fiber fabric attachments. But still further changes may come when the new enclosure materials come into general use.

Another direction for development, Hughes said, is improved laminating resins. A more heat resistant interlayer will be needed if the forthcoming transparent plastics are to be laminated for increased toughness and shatter resistance.

Powder Bearing Standard

A new standard, "Tentative Specifications for Metal Powder Sintered



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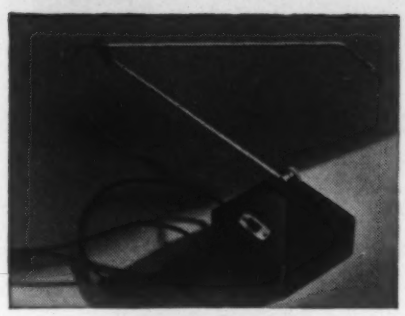
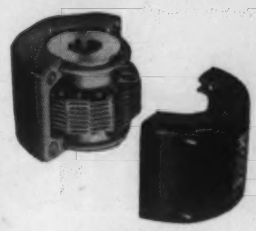
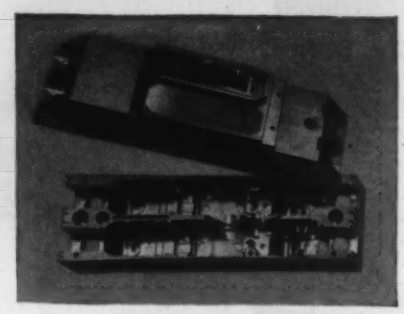


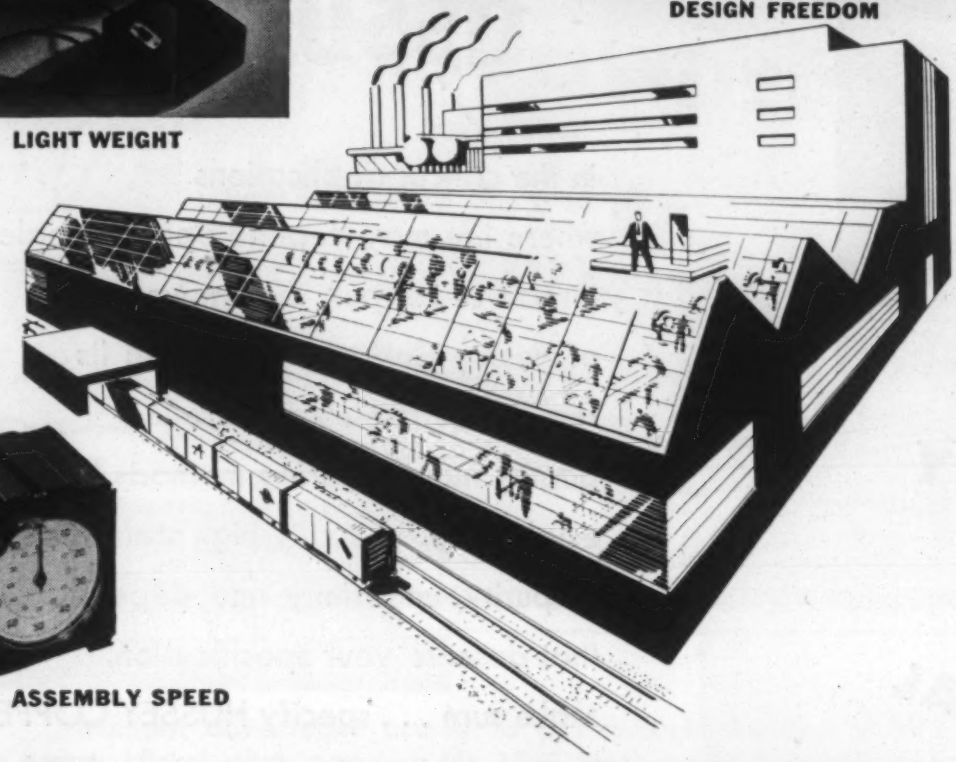
LIGHT WEIGHT

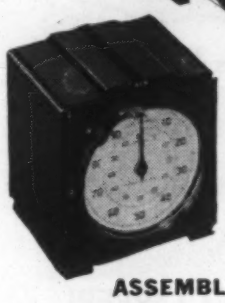


CORROSION RESISTANCE



DESIGN FREEDOM





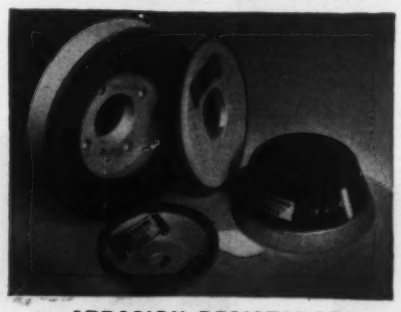
ASSEMBLY SPEED

with an eye to improving your product

● Go no further than your own plant whenever you seek material properties in wonder-working combinations. In one department after another you'll see equipment that works better, looks better and often lasts longer because Durez phenolic plastics are used in making it.

These examples only hint at the unequalled flexibility of Durez phenolics in fitting themselves to your blueprint. In simplicity of production and end-product characteristics alike, Durez materials are extending horizons for businessmen and their technicians in designing for future profits.

As resins applied to a product or integral in it, or as materials for molding into finished large and small units in custom molding plants, today's phenolics have more possibilities than ever before. Your engineers and molding men will find Durez—largest producer of phenolics exclusively—helpful in making them pay.



ABRASION RESISTANCE

DUREZ

PHENOLIC RESINS

MOLDING COMPOUNDS

INDUSTRIAL RESINS

PROTECTIVE COATING RESINS

Our monthly "Durez Plastics News" will keep you informed on industry's uses of Durez. Write, on office letterhead.

DUREZ PLASTICS & CHEMICALS, INC.
1403 Walck Road, North Tonawanda, N. Y.

Member S. P. I. Committee on Large Plastics Moldings

PHENOLIC PLASTICS THAT FIT THE JOB

News Digest

Bearings (Oil Impregnated)" has been issued by the Metal Powder Assn.

Designated M.P.A. Standard 16-52T, it is identical to ASTM Standard B202 prepared originally by ASTM Committee B-9. Together with M.P.A. Standard 14-51T, issued in 1951, the new specification provides complete standardization covering both iron-base and bronze-base metal powder oil-impregnated bearings.

The new standard is available at $.25 per copy from the Metal Powder Assn., 420 Lexington Ave., New York 17, N. Y.

Radical Press Design Change May Herald Larger Forgings

A new idea in press design, now being exploited by Throatless Press Co., may prove to be the answer for engineers who envision forgings of much greater size than today's largest.

Essentially, the new idea is to suspend the forging head from a massive concrete structure that will enclose the entire press and working space. The designers believe this design will make feasible presses of 75,000 tons or more.

One of the inherent advantages of such design is that it allows 360-deg access for placing and removing dies and work. The principal advantage, however, is expected to lie in the fact that giant columns and head and base frame castings will not be required.

The designers believe this will make it possible to limit the size of individual parts for large presses to a point where machining and transportation problems would be avoided and units could be erected in practically any location. By bringing construction of such presses within the range of existing machine tools and construction equipment, they feel they will remove the principal obstacles to building presses of 75,000 tons or more.

A 75,000-ton forging press would have more than four times the capacity of the biggest presses now in operation on this side of the Iron Curtain and more than twice that of the huge German press seized by the Rus-

Cold Forging...

...THE COST-SAVING SOLUTION.....FOR PARTS LIKE THESE

Did you know that many parts such as those pictured can be cold forged?

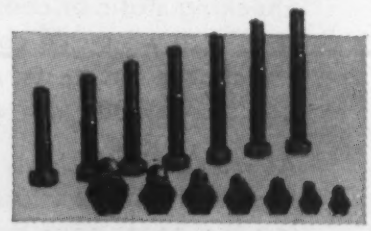
Through engineering and production methods which Allied employs, special cold forged parts can be produced in many unusual forms and sizes. In numerous instances, parts never before considered for this type of production have been manufactured by Allied.

Tolerances as close as are required for most machined parts can be secured. Cold forging processes invariably provide greater strength and durability in the parts produced. Of most importance, in high volume production, your part costs can be reduced considerably.

Send your part prints to learn what Allied can do for you.

Other Allied Products

HARDENED AND PRECISION GROUND PARTS • SHEET METAL DIES FROM THE LARGEST TO THE SMALLEST • ALLITE (ZINC ALLOY) AND PLASTIC DIES • JIGS • FIXTURES • R-B INTERCHANGEABLE PUNCHES AND DIES



STANDARD HEXAGON HEAD CAP SCREWS

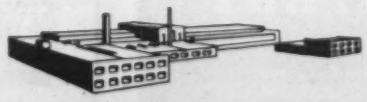
Also produced in Allied's Plant 1 are standard hexagon head cap screws. They are of uniformly high quality and are priced competitively. Your inquiries concerning these products will receive prompt attention.

PRECISION • EXPERIENCE • ALLIED CORPORATION PRODUCTS • DEPENDABILITY

ALLIED PRODUCTS CORPORATION

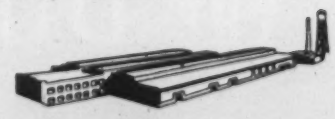
DEPT. D-11 • 12663 BURT ROAD • DETROIT 23, MICH.

PLANT 1
Detroit, Mich.

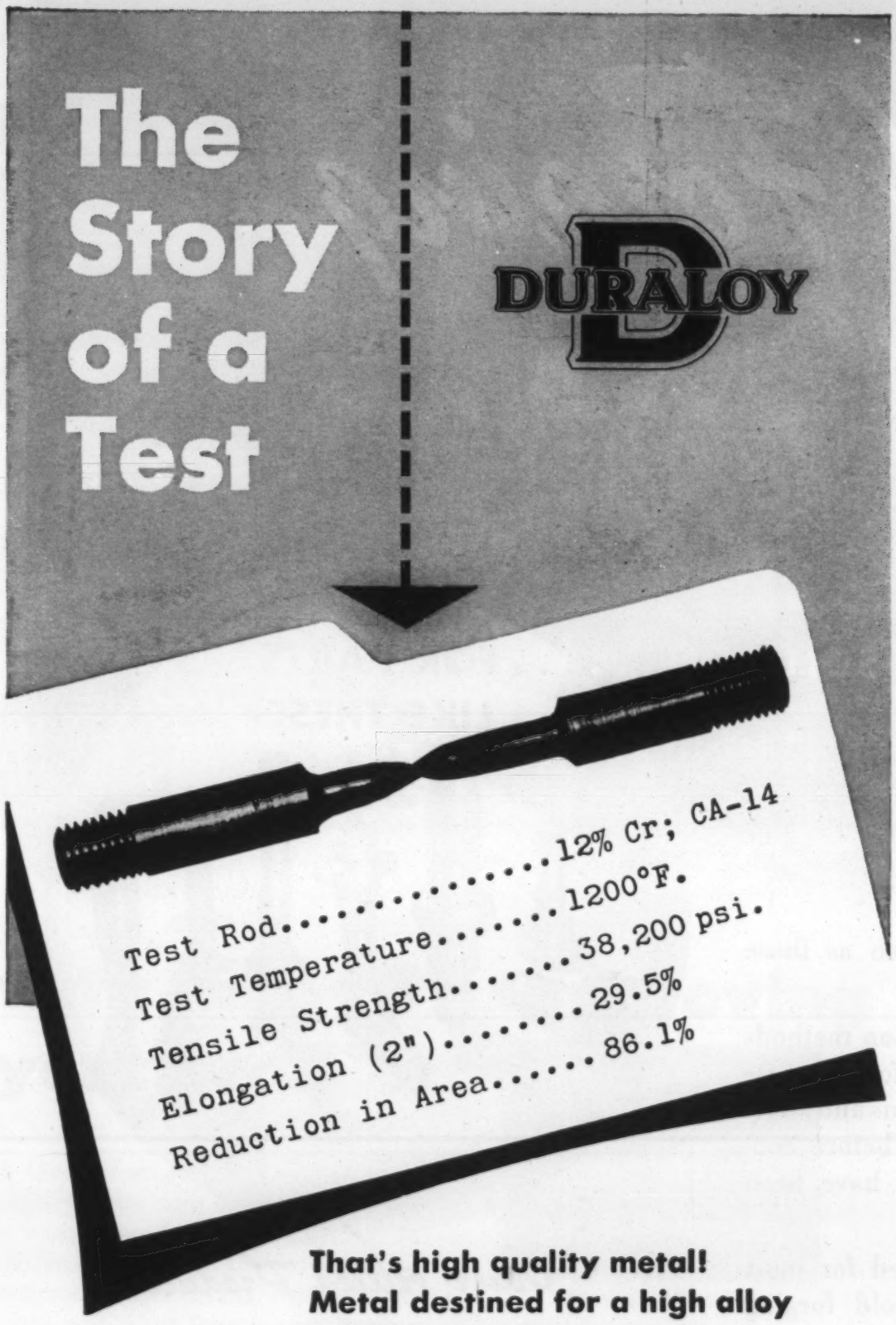


PLANT 2
Detroit, Mich.

PLANT 3
Hillsdale, Mich.



PLANT 4
Hillsdale, Mich.



That's high quality metal! Metal destined for a high alloy casting which has to meet some pretty rigid specifications!

The story we want to tell here is about our Testing Facilities. We have right in our foundry every conceivable testing facility needed when checking static or centrifugal high alloy castings for industry. Where required, we make complete chemical, metallurgical, and mechanical checks and tests. And have both a 400,000 volt X-ray unit and gamma-ray unit, for checking the final casting for hidden flaws.

As we see it, the only way to assure customers of high quality castings is to have and use all necessary facilities for testing and checking the heat, pour and finished casting.

THE DURALOY COMPANY

Office and Plant: Scottdale, Pa. • *Eastern Office:* 12 East 41st Street, New York 17, N.Y.

Atlanta: J. M. TULL Metal & Supply Co. — Detroit: W. D. HAZLETON 805 New Center Building — Chicago: F. O. NELSON 332 S. Michigan Avenue — San Francisco: JOHN D. FENSTERMACHER 1241 Taylor Street

METAL GOODS CORP. Dallas • Denver • Houston • Kansas City • New Orleans • St. Louis • Tulsa

News Digest

sians and now believed to be in operation beyond the Soviet border.

The Throatless Press Co. is owned by the Austin Co., an engineering and construction firm in Cleveland, and the Hydraulic Press Manufacturing Co. of Mt. Gilead, Ohio. It was formed for the specific purpose of developing, producing and erecting the new presses.

Measuring Corrosion Rates

A recent laboratory study by the National Bureau of Standards appears to prove for the first time that the rate of weight loss of a piece of steel corroding normally in soil can be measured electrically, without actually weighing the metal.

Conducted by W. J. Schwerdtfeger and O. N. McDorman of the NBS corrosion laboratory, the study gives further evidence that the electrochemical theory of corrosion applies generally to soils.

Although the NBS measurements were restricted to the laboratory, the success of the work suggests the possibility of valuable practical applications, such as determination of the corrosion rate of a tank or other underground structure without the need for visual inspection.

Copper Properties Hinge on Prior Strain History

Apparently it is important to know "how" as well as "how much" when it comes to evaluating the effect of prior strain upon the tensile properties of copper.

The National Bureau of Standards has found that the strength, ductility and hardness of high-purity copper at room temperature is markedly affected, not just by the amount of prior strain, but also by the manner in which it was achieved.

The study showed that cold-drawing copper at a relatively fast strain rate generally resulted in increased strength and hardness, but in decreased ductility. Prestraining at a high temperature or at a low strain rate, on the other hand, generally resulted in reduced strength and hardness as well as reduced ductility.

They bring . . .

SAVINGS IN TIME!

Another reason for changing to

PERMITE ALUMINUM CASTINGS

The easier handling that results when heavy metal parts are replaced by light-weight aluminum castings by Permite, can add up to important savings in time on your assembly lines. Fast machinability, dimensional accuracy, uniform quality are other Permite advantages that save production time.

Don't let the stresses, strains or other requirements your component parts must meet cause you to hesitate about investigating the many advantages of light-weight aluminum. Aluminum castings produced in Permite's modern foundries, under the close supervision of Permite aluminum specialists, have the structural soundness, the strength required for superior performance on many jobs formerly assigned exclusively to heavier metals.

If you have problems of production costs, faster assembly or other difficulties which might be solved by a change to light-weight aluminum castings — permanent mold, semi-permanent mold or sand — send us blueprints and specifications of your parts requirements. Recommendations and cost estimates by Permite engineers will be supplied promptly. No obligation.

ALUMINUM INDUSTRIES, Inc.

CINCINNATI 25, OHIO

Detroit: 809 New Center Building — New York: 9 Rockefeller Plaza

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PERMITE Aluminum Castings

ALUMINUM PERMANENT MOLD and SAND CASTINGS . . . HARDENED, GROUND and FORGED STEEL PARTS

Dissociated ammonia provides a protective atmosphere at lower cost, with better results

Bright heat treating is Allen B. DuMont Laboratories' answer to the problem of assuring absolute cleanliness of stainless steel components of their Teletron Picture Tubes. The electron gun is the heart of the television tube, and picture clarity depends on the quality of its essential parts.

DuMont has for some time been using dissociated ammonia as the only satisfactory atmosphere for bright heat treating of stainless steel. Not only is the cost of ammonia much lower than that of hydrogen, but the absence of water vapors improves the efficiency of the cleaning.

Since one cylinder of ammonia yields the equivalent of 34 cylinders of hydrogen—and is much less costly—dissociated ammonia may easily mean real savings for you, too. Write today, giving details of your requirements, and also send for one or all of the booklets offered below.

You can depend on Armour's Ammonia and Service

ARMOUR *Ammonia Division*

Armour and Company, 1355 W. 31st St., Chicago 9, Ill.

CLIP AND MAIL THIS TODAY!

Please send me copies of the following booklets:

☐ "Applications of Dissociated Ammonia" ☐ "The Nitriding Process"
☐ "Ammonia Installations for Metal Treating" ☐ "Carbonitriding"

*Name*_____ *Title*_____

*Firm*_____

*Address*_____

*City*_____ *Zone*_____ *State*_____

News Digest

continued from page 7

"But", says Goodyear's P. W. Litchfield, Chairman of the Board, "there is every reason to believe that these problems can be brought to a practical solution." He added, however, that in the foreseeable future the nation must continue to look to its GR-S facilities for the greater part of its general purpose synthetic.

Composition of Material

Butadiene and styrene, component parts of the nation's major supply of synthetic rubber, have no place in the production of the new polyester material. Basic ingredients, ethylene glycol and propylene glycol, are mixed with adipic acid to form the polyester base of the new rubber. This polyester is mixed with an amount of di-isocyanate so controlled as to halt the solidifying reaction at a point where the resultant material can be further processed on mills, calenders, extruders and other conventional rubber equipment.

When needed in production, the Goodyear rubber is given another di-isocyanate treatment and formed into final shape without the use of sulfur or accelerators for vulcanization. Carbon black and other reinforcing agents can be used, although not required as a stock-toughening material.

According to Dr. Dinsmore, the new type rubber is chemically similar to Germany's recently announced Vulcollan, developed by the German scientist, Dr. Otto Bayer. However, Dr. Dinsmore says, the German rubber does not permit delayed processing.

Vinyl Film Standard

A Recommended Commercial Standard for General Purpose Vinyl Plastic Film is being circulated to the industry and the public for written acceptance.

It is based on a proposal by the Society of the Plastics Industry and was modified to meet the desires of the majority at an industry conference last November.

The standard covers methods of test and requirements of general purpose plain or embossed vinyl plastic

Cold Cleaners

HOUGHTO-CLEAN 439 & 440

THE NEW COMBINATION THAT CLEANS METALS AT ROOM TEMPERATURE

No Hot Wash Needed

Now soils and oils can be removed *without* using a hot wash.

A new production line cleaning method recently perfected in Houghton laboratories gives you all these advantages when Houghto-Clean 439 and 440 are used:

- **NO need for stacks, vents, burners, heat controls**
- **NO heating costs (that saves plenty!)**
- **NO tendency to rust immediately after cleaning**
- **NO trouble in mixing**
- **NO extra expense for the cleaner itself—solution life is longer**
- **NO parts too hot to handle**
- **NO annoyances to personnel from hot, steamy installations**

Houghto-Clean 439 and 440 are a combination of alkali-solvent-wetting agents developed expressly for power washing on production lines at room temperatures. Try this new method and see how costs can be substantially reduced!
Write to E. F. Houghton & Co., Philadelphia 33, Pa.

Write Now

for bulletin describing this new cold cleaning combination—or ask the Houghton Man to show you how it works

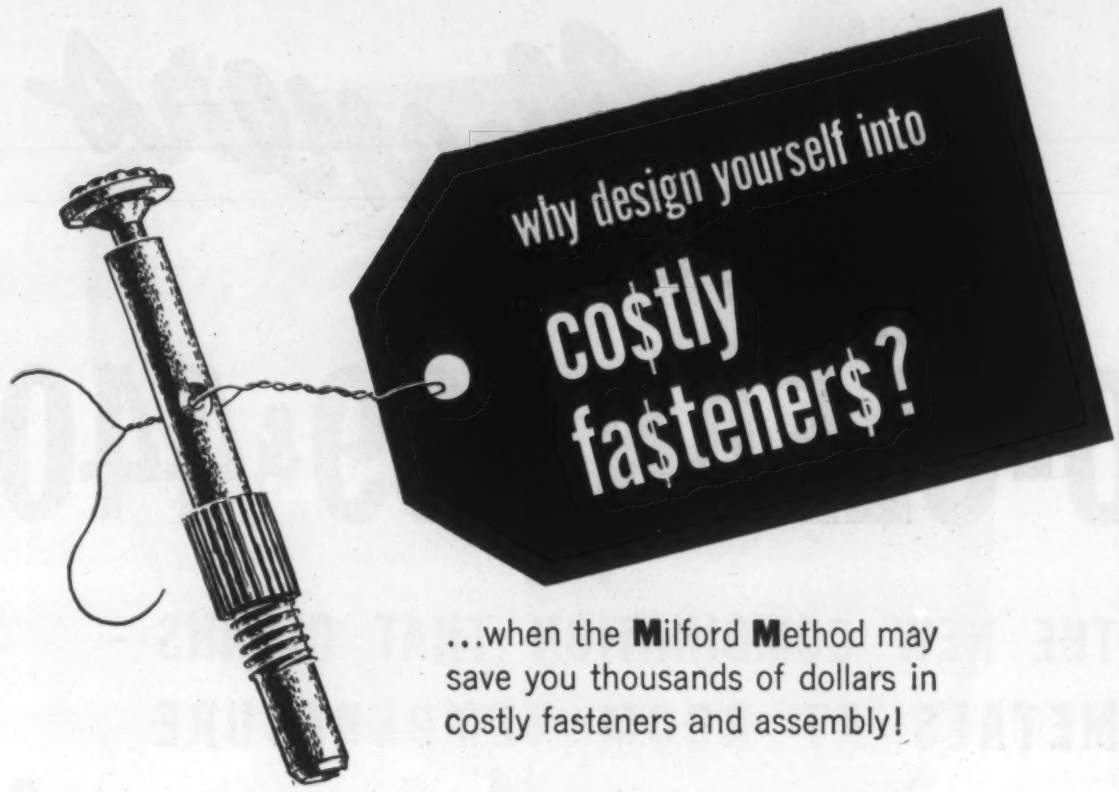
HOUGHTO-CLEAN 439 & 440

—cold cleaners produced by

E. F. HOUGHTON & CO.

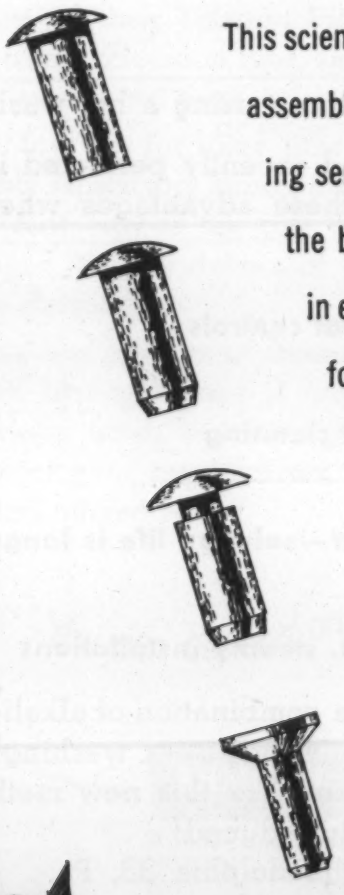
PHILADELPHIA • CHICAGO • DETROIT • SAN FRANCISCO

Ready to give you on-the-job service . . .



...when the **M**ilford **M**ethod may save you thousands of dollars in costly fasteners and assembly!

ask about the Milford Method



This scientific approach to product and parts assembly is a fastener-engineering consulting service which analyzes your needs at the blueprint stage... before you invest in expensive tools and dies! It projects for you the right fastener. Look into the economies of the "MILFORD METHOD" now. Send your blueprints and samples for analysis and planning by the "MILFORD METHOD", or write for the "Milford Method" brochure today.

EST. 1919

the **MILFORD RIVET & MACHINE CO.**

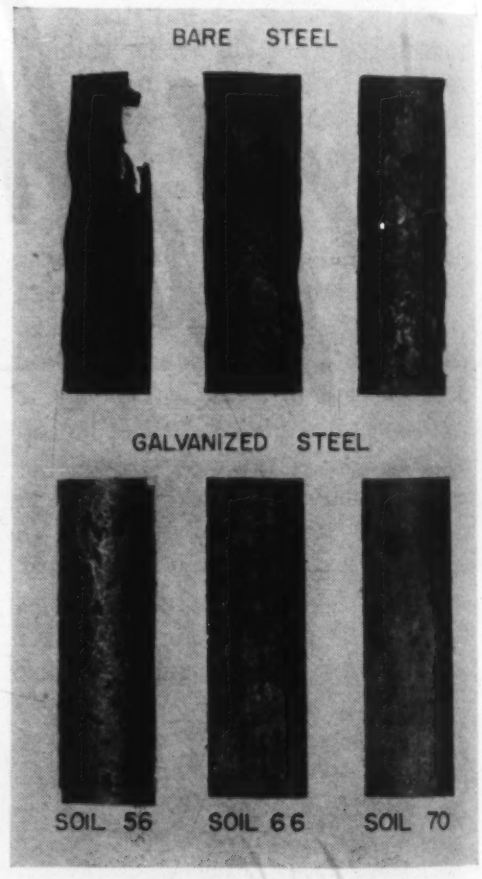
MILFORD, the name to rivet in your memory for fasteners.

859 Bridgeport Ave., Milford, Conn.
834 Illinois Ave., Aurora, Ill.
1110 W. River St., Elyria, Ohio
30 Platt Street, Hatboro, Penn.
721 So. Palm Ave., Alhambra, Calif.

News Digest

film. Specified are: thickness tolerances, yield per roll, width tolerances, shinkage at elevated temperatures, contamination, appearance, cracking, tensile properties, tear resistance, volatility of plasticizer, water extraction, low temperature impact and flammability. Suggested forms for declaring compliance with the standard and an identifying hallmark are included.

Mimeographed copies of the standard, which is identified as TS-5165, may be obtained from F. W. Reynolds, Commodity Standards Div., U. S. Dept. of Commerce, Washington 25, D. C.



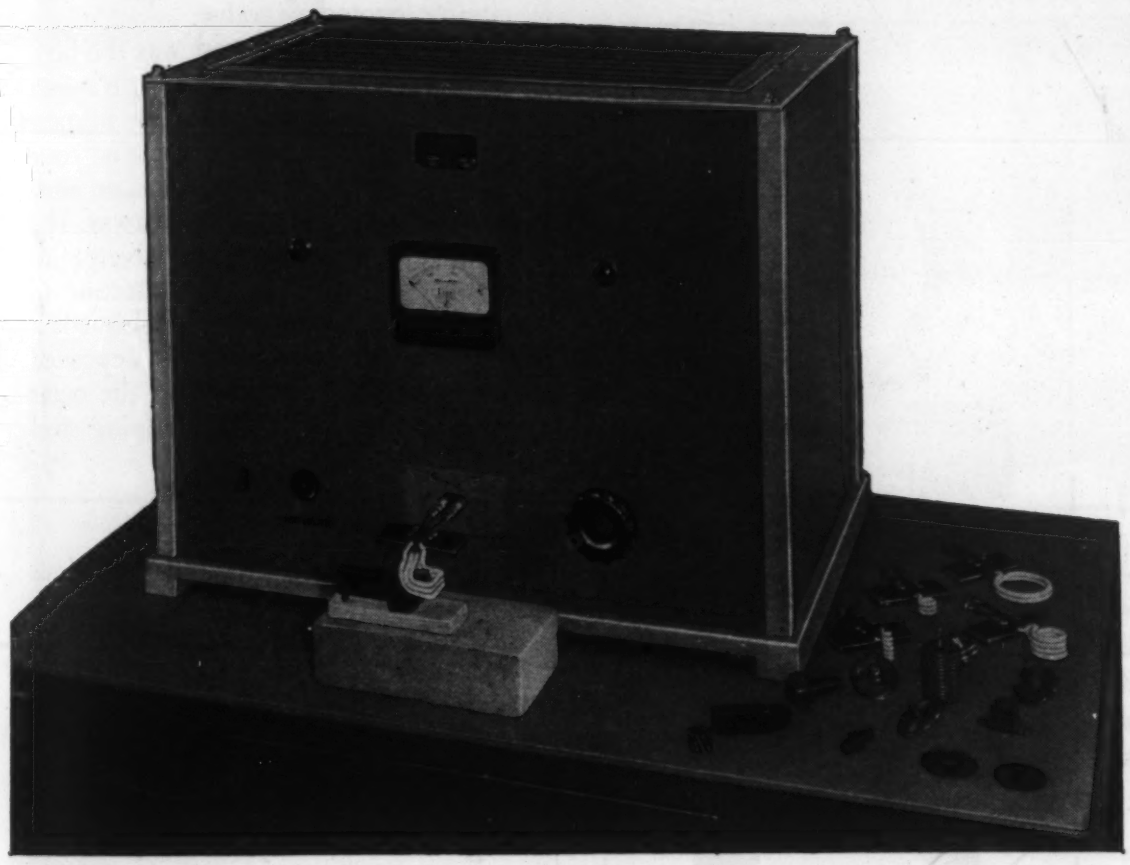
Galvanized Steel Pipe Resists Soil Corrosion

The effectiveness of hot-dipped galvanized steel pipe in resisting soil corrosion has been confirmed in a recent study by the National Bureau of Standards.

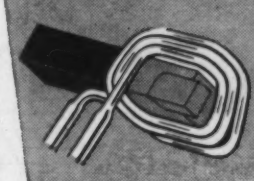
Results of an investigation by Irving A. Denison and Melvin Romanoff show that galvanized steel having 3 oz of zinc per sq ft of exposed surface is highly resistant to corrosion in many soils which are highly corrosive to bare steel. Their tests were carried

Lepel presents

A Low Cost PORTABLE HIGH FREQUENCY Induction HEATING UNIT

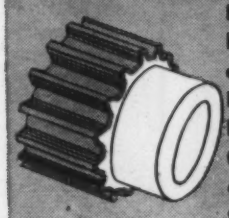


BRAZING



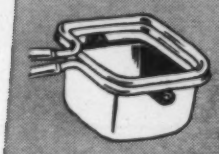
Permits widest choice of silver or copper brazing alloys from lowest to highest melting points. Ideal for brazing carbide tips.

HARDENING



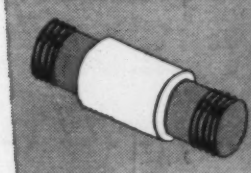
Heat localized exactly where wanted at desired temperature. Ideal for gears, cams, bearing surfaces, cutting tools and other areas that are subject to wear.

SOLDERING



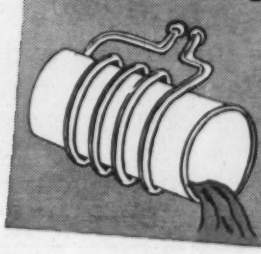
Speedily and neatly performs intricate soldering applications with or without the use of pre-formed rings.

ANNEALING



Ideal for annealing, stress-relieving, normalizing or preheating selected areas.

MELTING



Readily melts quantities of ferrous and non-ferrous metals in either graphite or ceramic crucibles.

- **SMALL AND COMPACT**
  Conveniently operated on bench or table—no mounting necessary.
- **ECONOMICAL OPERATION**
  No special power installation required. Operates on 110 volts, 60 or 50 cycle line at unity power factor.
- **FULLY GUARANTEED**
  Guaranteed for continuous duty cycle and stated performance.

This versatile unit is priced so low that every shop may now take advantage of modern induction heating techniques to improve quality and to increase production. Its simplicity of operation eliminates the need for skilled personnel.

The Lepel Model 2 KW will meet the requirements of machine shops, toolrooms, research laboratories and educational institutions. It is especially suitable for hardening, brazing and soldering small parts of either ferrous or non-ferrous metals.

Complete unit with line connection and load coil.

$870.
f.o.b. factory

WILL HEAT TO 1500° F.

⅛"	steel	rod	1"	length	in	approx.	1 second
¼"	"	"	"	"	"	"	3 seconds
½"	"	"	"	"	"	"	15 seconds
1"	"	"	"	"	"	"	60 seconds

Will melt 4 ounces of brass or steel in 4 minutes.
Equally well suited for heating of non-ferrous metals.

LEPEL HIGH FREQUENCY LABORATORIES, INC.
55th STREET and 37th AVENUE, WOODSIDE 77, NEW YORK CITY, N. Y.

All Lepel equipment is certified to comply with the requirements of the Federal Communications Commission

WRITE FOR LEPEL CATALOG MM-3

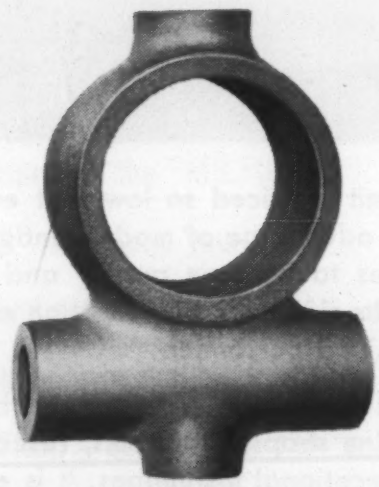
PUTTING TOGETHER JIGSAW PUZZLES CAN BE AN EXPENSIVE PASTIME!

And that is what is being done—wasting productive manpower in time consuming "jigsaw" assembly. Small fabricated parts can be cast in a single unit with better appearance and less cost by Sacks-Barlow and Newark Malleable.

Ask us to go over *all* of your parts and help you eliminate the costly "jigsaw" operations. You're sure to make worthwhile savings in production costs with our gray, malleable and ductile iron castings.

GREATER PRODUCTION, GREATER SAVINGS . . . THROUGH CASTINGS!

THIS IS A WASTEFUL "JIGSAW" FABRICATION
4 different small parts welded together



AND THIS is the same part cast in a single unit . . . for a production saving of 26%!

SACKS-BARLOW
FOUNDRIES, INC.
NEWARK MALLEABLE IRON WORKS
357 Wilson Avenue, Newark, N. J.
Resident Representatives in
New York, Philadelphia, Boston, Baltimore and Providence, R. I.

News Digest

out on samples exposed up to 13 years and in many different parts of the country, representing a wide range of soil properties.

A Continuous Coating

In one soil in which bare steel pipe was perforated by corrosion after exposure for only a few years, the coating on the galvanized specimens remained perfectly continuous throughout the 13-year period. In only two of the 15 soils, both organic, was the zinc coating of negligible protective value.

Of particular interest was the high corrosion resistance the galvanized specimens continued to show in most of the soils after the outer zinc coating, and even after the zinc-iron alloy layer, had entirely corroded away. The NBS investigators tentatively attribute this continuing protection to an inorganic coating, probably silicious, which they believe is deposited by galvanic action between the outer zinc coating and the underlying steel or alloy layer.

Weights Required Vary

Data based on this and a previous NBS study indicates that the minimum weight of zinc coating required to protect steel for a minimum of 10 years depends on the nature of the soil environment. A 2-oz coating was found to give sufficient protection in inorganic oxidizing soils, but for inorganic moderately reducing soils a 3-oz coating was required. Highly reducing soils, both organic and inorganic, require coatings heavier than 3 oz per sq ft.

In order to obtain maximum life from galvanized pipe in practice, it is necessary either to construct the entire piping system of galvanized pipe or else to electrically insulate the galvanized sections from pipe of other materials. Otherwise, the zinc coating will be removed by galvanic action.

Bort Conservation Measures Pressed

The Government's campaign to conserve and stretch out the available supply of industrial diamonds has been intensified recently, with the National Production Authority of the

Large diameter

TRENTWELD STAINLESS TUBING

for your requirements

TRENTWELD Large Diameter Stainless Steel Tubing meets precisely the tubing requirements of fabricators, designers and manufacturers of processing equipment. Available in diameters of 4″ to 40″ OD, TRENTWELD is precision-finished with absolutely uniform section. TRENTWELD is furnished in any finish, for fabrication with any fittings you select. Call on us.

CONDENSING LOOPS FOR HANDLING MERCURY VAPOR AT A WESTERN MINE. FABRICATED OF CR-NI STAINLESS STEEL.

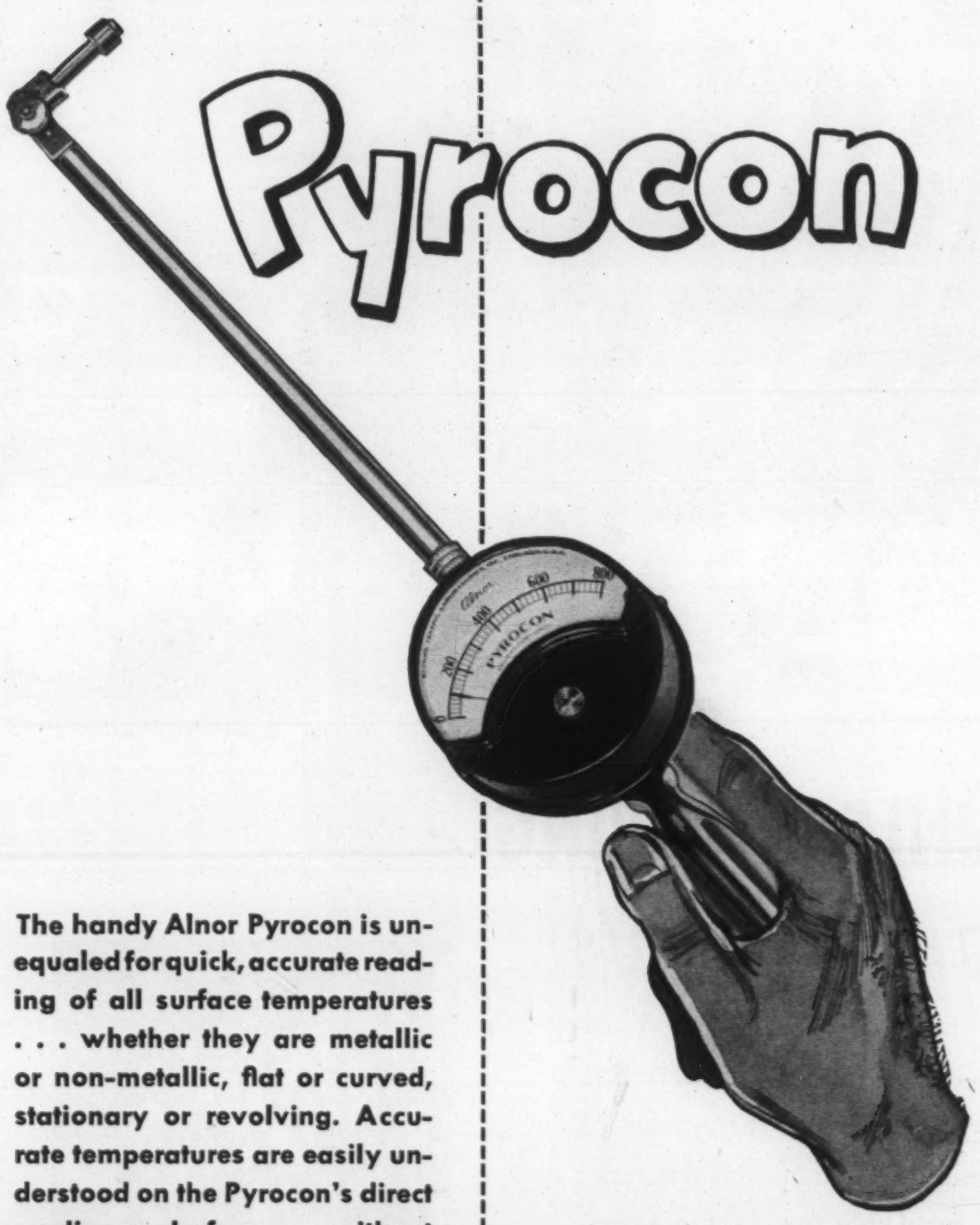
TRENTWELD

STAINLESS STEEL TUBING

TRENT TUBE COMPANY, GENERAL SALES OFFICES, EAST TROY, WISCONSIN (Subsidiary of CRUCIBLE STEEL COMPANY OF AMERICA)

Take surface temperatures quickly, accurately... with the

Pyrocon



The handy Alnor Pyrocon is unequaled for quick, accurate reading of all surface temperatures . . . whether they are metallic or non-metallic, flat or curved, stationary or revolving. Accurate temperatures are easily understood on the Pyrocon's direct reading scale face . . . without interpolation or need of conversion tables. A wide selection of thermocouples and extension arms permits adaptation to many types of service. For complete details and prices, send for Bulletin No. 4257. Illinois Testing Laboratories Inc., Room 522, 420 N. LaSalle Street, Chicago 10, Ill.

Alnor

PRECISION INSTRUMENTS
FOR EVERY INDUSTRY

News Digest

Dept. of Commerce holding a series of regional conferences to acquaint large users with the critical situation.

It is estimated that about 7,500,000 carats of bort, the grade of diamond below gem quality and used industrially, will be available to U. S. industry this year. Industrial requirements will be 9 to 10 million carats. The difference must be made up by (1) use of other abrasives where practicable, (2) greater care in the use of diamond abrasive when used, and (3) reclamation of diamond material.

Silicon Carbide Wheels

It is believed by some that silicon carbide wheels can replace diamond wheels for as much as 90% of the grinding of cemented carbide tools. Diamond wheels are necessary for most thread grinding, for cut-off operations, grinding chip breakers, internal jobs, special form jobs and for cutters 10 in. or larger, but even here silicon carbide wheels are useful for the rough grind.

Since an unskilled operator will use much more diamond material for a given job than a skilled operator, it has been suggested that use of diamond abrasives be limited to skilled operators to further cut consumption.

Reclamation Widely Practised

Reclamation of diamond material from grinding sludge and dust, broken wheels and wheel stubs has been practiced by large users for many years. Such wastes are returned to processors where the diamond material is separated, graded and blended with new bort for reuse.

The Grinding Wheel Institute and the individual manufacturers of diamond abrasives have been cooperating with the NPA in disseminating information on the conservation of diamond abrasives.

At least one company has gone further than that. Aiming at more efficient use of diamond bort, the Norton Co. has been studying the application of a process known as "electrolytic grinding" to cemented carbide stock removal. This method utilizes simultaneous electrolysis to assist conventional diamond wheel grinding.

Electrolytic Grinding

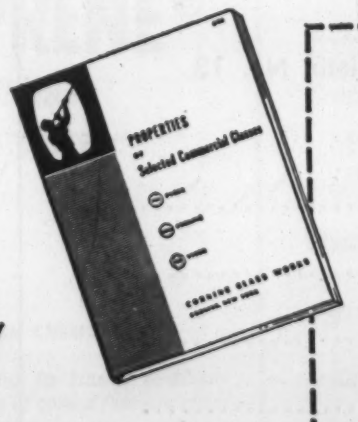
The tool or workpiece, which is positive in a direct current electric circuit, is separated a minute amount

Glass Code	Type	Color	Principal Use	Thermal Expansion Coeff.—/°C	UPPER WORKING TEMPERATURES (Mechanical Considerations Only) Annealed Normal Service °C	Annealed Extreme Limit °C	Tempered Normal Service °C	Tempered Extreme Limit °C	Thermal Shock Res. Plates 6"x6" Annealed ⅛" Thk. °C	¼" Thk. °C	⅓" Thk. °C	Thermal Stress Resistance °C	Viscosity D Strain Point °C	Annealing Point °C	Soft
0010	Potash Soda Lead	Clear	Lamp Tubing	91x10⁻⁷	110	380	—	—	65	50	35	19	397	428	6
0041	Potash Soda Lead	Clear	Thermometers	84x10⁻⁷	110	400	—	—	70	60	40	19	426	460	
0080	Soda Lime	Clear	Lamp Bulbs	92x10⁻⁷	110	460	220	250	65	50	35	17	478	510	
0120	Potash Soda Lead	Clear	Lamp Tubing	89x10⁻⁷	110	380	—	—	65	50	35	17	400	433	6
1770	Soda Lime	Clear	General	82x10⁻⁷	110	450	220	250	70	60	40	19	470	503	7
2405	Hard Red	Red	General	43x10⁻⁷	200	480	—	—	135	115		36	506	537	8
2475	Soft Red	Red	Neon Signs	91x10⁻⁷	110	440	—	—				17	466	501	6
3321	Hard Green Sealing ..	Green	Sealing	40x10⁻⁷	200	470						39	497	535	7
4407	Soft Green	Green	Signal Ware	90x10⁻⁷								17	485	518	6
6720	Opal	White Opaque	Gen									19	499	531	
6750	Opal	White Opaque										8	445	475	
6810	Opal	White Opaque											496	529	
7050	Borosilicate	Clear											461	496	7
7052	Borosilicate	Clear											438	475	7
7070	Borosilicate	Clear	La Ele										455	490	
7340	Borosilicate	Clear	Gau									20	538	575	7
7720	Borosilicate	Clear	Elect							130	90	45	484	518	7
7740	Borosilicate	Clear	Gene					290	180	150	100	48	515	555	8
7760	Borosilicate	Clear	Electri			450	250	250	160	130	90	51	475	515	7
7900	96% Silica	Clear	High Te	10⁻⁷	800	1090	—	—	1250	1000	750	200	820	910	15
7900	96% Silica (Multiform)	White Opaque	High Temp.	8x10⁻⁷	800	1090	—	—	1250	1000	750	200	820	910	15
7910	96% Silica	Clear	Ultra Violet Transmission	8x10⁻⁷	800	1090	—	—	1250	1000	750	200	820	910	15
7911	96% Silica	Clear	Ultra Violet Transmission	8x10⁻⁷	800	1090	—	—	1250	1000	750	200	820	910	15
8870	High Lead	Clear	Sealing or Electrical	91x10⁻⁷	110	380	180	180	65	50	35	22	398	429	5
9700	.....	Clear	Ultra Violet Transmission	37x10⁻⁷	220	500	—	—	150	120	80	42	517	558	8
9741	.....	Clear	Ultra Violet Transmission	39x10⁻⁷	200	390	—	—	150	120	80	40	407	442	7

HAVE YOU OVERLOOKED SOME OF THE PROPERTIES OF GLASS?

Glass is such a commonplace material, it's easy to overlook the many properties it can be made to possess—properties which may well prove the answer to your material problem. The above table suggests the wide variations in glasses available at Corning for various applications. You'll find Corning has hundreds of glasses with other important characteristics you may need—unusual corrosion resistance, high physical and thermal shock resistance, optical clarity, and controlled light transmission, to name a few.

Take a fresh look at your present and projected equipment. Glass may be the material you're looking for to improve performance and lower costs. Then bring your ideas to Corning and let our engineers choose a glass for you. We have the glass and technical experience, backed up by research and pilot plant facilities, to develop your idea, and a broad variety of production facilities to produce it. For a quick look at some properties of glasses by Corning, send the coupon below for Bulletin B-83, "Properties of Selected Commercial Glasses."



Corning means research in Glass

Corning Glass Works

Dept. MM-3, Corning, N.Y.

Please send me Bulletin B-83, "Properties of Selected Commercial Glasses."

NAME_____ TITLE_____

COMPANY_____

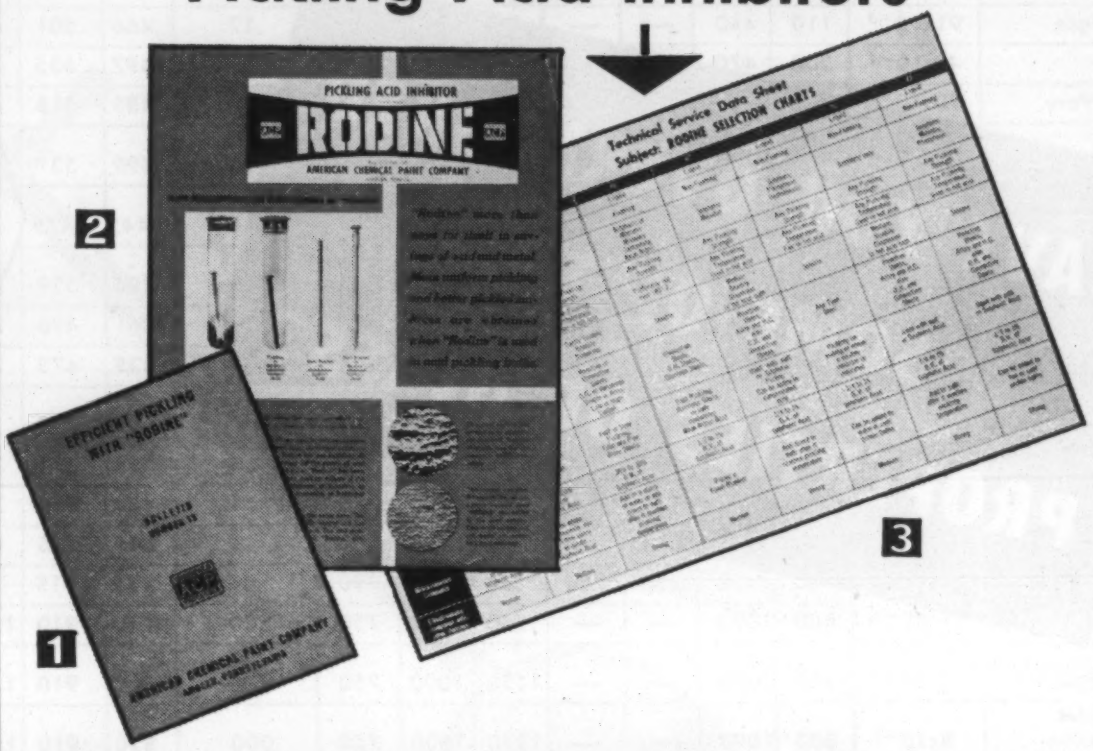
ADDRESS_____

CITY_____ ZONE____ STATE_____

New Data Available on . . .

RODINE®

Pickling Acid Inhibitors



1 The standard reference work on pickling, "Efficient Pickling With RODINE" — Bulletin Number 13 — is now available in a new, revised edition.

2 This new 4-page general descriptive folder presents essential information on "Rodine" pickling acid inhibitors.

3 The recently revised "RODINE SELECTION CHART" gives characteristics of and uses for typical "Rodines" used with sulfuric and muriatic acids. Technical Service Data Sheet No. 13-1-1-4.

Use coupon below for free copies of the literature described above.

AMERICAN CHEMICAL PAINT COMPANY

***General Offices:* Ambler, Penna.**

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CHEMICALS ACP PROCESSES

CLIP AND MAIL TODAY!

American Chemical Paint Co.
Ambler, Pennsylvania

Gentlemen:

Please send me FREE:

- ☐ "Efficient Pickling With RODINE" — Bulletin No. 13.
- ☐ 4-page general descriptive folder.
- ☐ "RODINE SELECTION CHART"

Name .....

Company Name .....

Address .....

City ..... State .....

News Digest

from the metal bond of the diamond wheel, which is negative, a suitable electrolyte flowing between them. The diamond particles act both as an abrasive to remove stock in the conventional manner and as effective nonconducting spacers to prevent metal-to-metal contact between the work and the metallic diamond wheel bond during electrolysis.

The company has limited its studies to the sharpening of singlepoint carbide tools since the Government has tabbed this operation as the largest single consumer of diamond bort.

Results of these studies are inconclusive at present. Although modification of surface and edges due to electrolytic assistance has been demonstrated, the practical effect upon performance and life of tools so ground has not yet been commercially established.

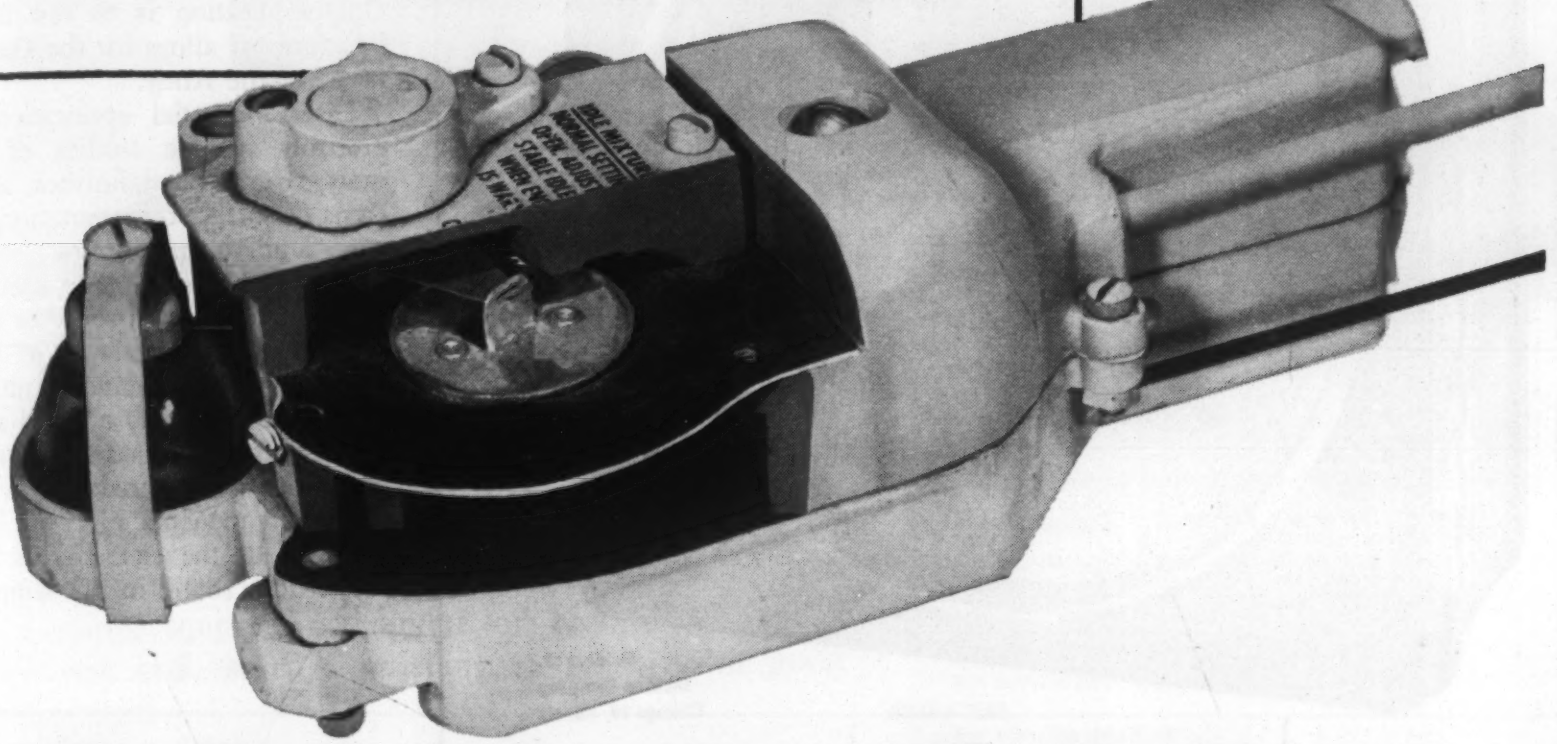
New Atom Smasher to Study Materials

The rebounding action of billiard balls finds its counterpart in a new method of analyzing materials. Nicknamed "Proton Bombarder", a $200,000 ion-scattering analyzer developed by Stanford Research Institute identifies and measures minute quantities of elements in surface substances by bouncing a stream of protons off the atoms in a sample.

Joining a two-million volt generator, a 20-ft vacuum tube, and two large electromagnets, Stanford Research Institute's new bombarder weighs 5 tons. Yet, in any sample, it can detect an element in an amount weighing only one-millionth of one-millionth of a gram—or about one thirty-trillionth of an ounce.

The method evolved from apparatus and techniques developed in atom-smashing research. In an atom-smasher, however, protons hit their target with such great velocity that the atoms are altered. Protons in the

Up, Down or Around...



Floatless carburetor with diaphragm of Du Pont "Fairprene" delivers full power

This floatless-type carburetor keeps a McCulloch chain saw working full blast—*in any position it's used!* The diaphragm McCulloch Motors chose for their 7-55 and 5-49 model chain saws was Du Pont "Fairprene"* coated fabric. They chose "Fairprene" because it makes a highly sensitive diaphragm; stays flexible, hot or cold; keeps its shape; is lightweight; and remains gasoline-resistant *longer!*

In diaphragms such as the one used in these chain saws, as in hundreds of other industrial applications, Du Pont "Fairprene" is also preferred because it's extremely tough, resists oil, grease, kerosene and aging in air, oxygen or gases.

Du Pont engineers are eager to help you evaluate "Fairprene" for designing new products, or for improving your present products or manufacturing methods. They'll gladly work with you in engineering special grades of "Fairprene" to meet *your specific needs.* For prompt assistance, fill out and mail the coupon below. Do it today!

DU PONT FAIRPRENE®

synthetic elastic compositions

"ENGINEERED TO DO YOUR JOB BETTER"

DU PONT
REG. U. S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING... *THROUGH CHEMISTRY*

**"FAIRPRENE" is Du Pont's registered trade-mark for its line of products made from synthetic elastomers available in the form of coated fabrics, sheet stocks without fabric insert, and adhesives.*

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Please send me booklet "'FAIRPRENE' synthetic elastic compositions."

Name_____ Title_____

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Address_____

Dickson pens the temperature-

Product of
Dickson Company
Chicago 19, Illinois

THE Dickson multi-range Minicorder Type 1A is designed to draw a continuous chart record of the exact surrounding temperatures. With this multi-range recorder, extremely accurate recordings can be made of the temperatures in deepfreeze compartments, standard refrigerators, general air conditioning and other temperature controlled areas. The compact Minicorder measuring element is a specially designed spiral coil of Chace Thermostatic Bimetal calibrated to move a pen across the chart with a temperature change of 45°.

The precision-wound coil is fixed to the outer end of the mounting on the back of the dial. A pen with an extended arm is attached to a shaft that is spot welded to the inner end of the coil. Changes in room temperature cause the element to react in a coiling or uncoiling motion, thus causing the pen to move left or right, recording the temperature. At the same time a spring wound clock rotates the chart to synchronize the time with the temperature reading.

The accuracy of this multi-range recorder is dependent upon precision manufacturing and assembly methods. We fabricate this type of coil from precision-rolled strip stock in a controlled-temperature department. We also provide our 29 types of thermostatic bimetal in elements to customer design, in strips, random coiled lengths or welded or brazed sub-assemblies. Before proceeding with your next design, consult our Application Engineers or write for our 32-page booklet, "Successful Applications of Chace Thermostatic Bimetal," containing condensed engineering data.

IT BENDS WITH THE HEAT

W. M. CHACE CO.
Thermostatic Bimetal
1615 BEARD AVE., DETROIT 9, MICH.

News Digest

new analyzer, traveling at lesser speeds, bounce off the atoms without changing them.

The Institute will shortly use its analyzer to study the properties and surface behaviors of various metals. One application is to test metallic structures of alloys for the Ordnance Dept. of the Army.

Later industrial applications will probably include studies of lubricants, coatings and finishes, and analysis of surface contaminations or of minute unknown samples.

The complex apparatus at Stanford Research Institute is superior to previous analyzing methods in several ways. Since the substance is unaltered by the analysis, only a small spot of the surface is needed for sampling. In addition, the analyzer, with its various components, plots out a curve showing all the elements and their proportions found in the sample.

News of Engineers

Paul Porterfield has been appointed general manager of The Method X Co., an affiliate of Firth Sterling, Inc. Mr. Porterfield succeeds *John S. Roller*, who resigned to take up new duties with Firth Sterling.

C. W. Heppenstall was appointed manager of forging operations at the Air Force's heavy press plant for aluminum forgings at Newark, Ohio, to be operated by Kaiser Aluminum & Chemical Corp.

Expanding operations at the Goodyear Aircraft Corp. have resulted in the appointment of *C. E. Lehman, W. D. Burns, Albert Goulding, R. B. Willett* and *C. H. Zimmerman* to head five newly-organized production divisions. Mr. Lehman was named manager of the new Lighter-than-Air Production Div.; Mr. Burns, manager of the Parts Manufacturing Div.; Mr. Willett, manager of the Special Products Div.; and Mr. Zimmerman, manager of the Wheels, Brakes and Rocket Div.

Carroll B. Dick, formerly works manager of the Westinghouse Electric Appliance Div. plant at East Springfield, Mass., has been appointed manager of the company's Micarta Div., to succeed *E. R. Perry*, who has resigned to accept a new position. Other news from the company

WE MAKE AND FABRICATE...
STRONG, LOW-COST SPIRAL TUBING

Spiral Tubing, another outstanding C-D-F product, is an important new material for the progressive, cost conscious design engineer (and purchasing agent). It is a high strength plastic made from paper or fibre that is spirally wound, then impregnated with phenolic resin or insulating varnishes and carefully cured at high temperatures. The resulting tubes (round, square, rectangular or formed to special shapes) are stiff, sturdy, resistant to crush, with good tensile strength.

This unique product has good dielectric strength with low dielectric loss properties. Moisture resistance and dimensional stability is easily controlled in the manufacturing process. The wide variety of sizes, shapes, forms; the strength; low cost; ease of fabrication; speed of delivery; all combine to make C-D-F Spiral Tubing worthy of your investigation.

PRIMARY APPLICATIONS

COIL FORMS OF ANY SIZE OR SHAPE
- for tuned or untuned RF, IF, oscillator, and other coils used in radio, television, electronic circuits
- for solenoids, relays, circuit breakers
- for transformers
- for permeability tuners

INSULATORS
- for selenium rectifiers
- for electric motors
- relays

BUSHINGS OR SPACERS
- armature shaft spacers
- for mechanical support

SHIPPING PROTECTORS AND FOR SPECIALIZED PACKAGING

BOBBIN TUBES

BODIES FOR PAINT ROLL APPLICATORS

AS A COMBINATION MATERIAL
- with other C-D-F high strength plastics or electrical insulating materials

SIZES

The round tubing ranges from 3/32 to 8" ID, with wall thicknesses from .0075 to ¼". The minimum ID of square and rectangular tubing is ⅜", with 2⅛" the maximum ID. Wall thicknesses range from .010 to 3/32".

Standard lengths are from 2 to 4', with special sizes and grades, plain or impregnated, open for your discussion with our C-D-F sales and engineering staff.

FABRICATION

Spiral Tubing is readily sawed, punched, drilled, tapped, riveted, stamped, painted, depending on the grade; it is suitable for automatic machine operations, but not recommended for conventional machine threading. Waxing or varnish impregnation to improve moisture resistance is usually done on the finished coils by the user.

GRADE SELECTION

C-D-F has mass production facilities for both the manufacture and fabrication of eighteen distinct grades of Spiral Tubing. For example, there's a special punching grade, fine for punching rectangular or square holes near the end of the tube. A relatively soft tube is supplied for difficult stapling or riveting. C-D-F makes high strength automotive electrical bushings from a very hard tubing with high axial compressive strength. Combinations of kraft, chipboard, Diamond "fish paper" Insulation, and other materials are available.

FORMS: ROUND • FORMED • FORMED AND NOTCHED • SQUARE AND RECTANGULAR

THE NAME TO REMEMBER CDF FOR SPIRAL TUBING

Continental-Diamond Fibre Company

NEWARK 25, DELAWARE

Remember, C-D-F has production know-how, years of experience in electrical insulation. See your C-D-F sales engineer. Write now for new 1953 spiral tubing folder, a workbook showing grades, applications, properties.

650° F.

STEADY OR WITH RAPID FLUCTUATIONS

MYCALEX INSULATION CAN TAKE BOTH OF THOSE TEMPERATURE CONDITIONS

It holds inserts tightly, and moves with the metals around it, because it has very nearly the same coefficient of thermal expansion as the most important metals of which inserts and casings are made.

DESIGNER! UNCHAIN YOUR IMAGINATION!

The destructive effects of high operating temperatures, high ambient temperatures, thermal expansion as between metals and insulations, have caused you to make too many items too much bigger and heavier than they need to be.

MYCALEX glass-bonded mica also is dimensionally stable, corona resistant, does not carbonize under arc, has no moisture absorption.

THERE ARE PLENTY OF OTHER USEFUL FEATURES . . . WRITE for the whole story

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THE INSULATOR
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GENERAL OFFICES AND PLANT

124 CLIFTON BOULEVARD, CLIFTON, N.J.

News Digest

announces the appointments of *W. R. Sugg, Jr.* as assistant manager of the Transportation and Generator Div. at East Pittsburgh; *G. A. Moore* as manager of manufacturing for the division; and *P. C. Smith* as manager of that division.

Three additions to the engineering staff of the Carboloy Dept., General Electric Co., Detroit, have been announced. Dr. *Robert F. Stoops* has joined the advance development section; *Anthony D. Cortese* has joined the design and application section; and *Frank B. Nuelle* has been transferred to the Detroit plant from Schenectady, assigned to the administrative engineering section. Three members of the Carboloy Dept. in Detroit have received the company's highest award for outstanding employee achievement. Charles A. Coffin awards were made to: *Otto K. Hittenberger,* general foreman; *Ernest A. Hughes*, supervisor, electrical maintenance; and *Perry D. Weiser,* application. A fourth, *Francis W. Pierson,* methods equipment specialist, received honorable mention. Dr. *John E. Jacobs*, manager of the Advanced Development Laboratory at the X-Ray Dept. of G-E in Milwaukee, also received the Charles A. Coffin award. Dr. Jacobs was responsible for converting cadmium sulfide crystals from a laboratory curiosity into a highly-sensitive, automatic detector for inspecting numerous industrial products. The coveted award consists of five shares of G-E stock, a lapel pin and certificate. Seven executives have been named managers of newly-established engineering services departments in the company's General Engineering Laboratory in Schenectady, according to another company announcement: The new managers and departments are: *Frederick E. Crever,* Thermal Power Systems Engineering Div.; Dr. *G. Wesley Dunlap*, Instrument and Radiation Engineering; *Richard K. Fairley,* Engineering Measurement and Analysis; *Donald E. Carr*, Electro-Mechancial Engineering; *Charles D. Greentree,* Engineering and Consulting Application; *Ernest E. Johnson,* laboratory general manager, who will temporarily fill the post of acting manager of Materials and Chemical Process Engineering; and *Donald L. Wright,* Auxiliary Operations.

Dr. *Kenneth C. Vincent* has been appointed supervisor of extraction metallurgy at Armour Research Foundation of Illinois Institute of Technology. Before joining the Foundation, Dr. Vincent was chief metallurgist for the Baroid Sales Div., National Lead Co.

James M. White has been elected vice president in charge of manufacturing of the American Car and Foundry Co. This announcement coincides with the retirement of *Robert W. Ward,* vice president, after 42 years of service, whom Mr. White succeeds. Appointment of *Herbert D. Euwer* as chief engineer, passenger cars,

short run stampings

DESCRIBED IN NEW CATALOG No. 718

New catalog describes HPL's "know-how" which can save up to 80% of conventional tooling costs.

Facilities for producing stampings in runs of 25 to 25,000 pieces in various shapes and materials are described and shown. **HPL** is making this attractive four-page catalog available to production, purchasing and management personnel to assist them with their stamping problems. Catalog No. 718 will be sent to you upon receipt of publication or letterhead request.

1120-HPL

HPL
Manufacturing Co.

15195 MILES AVE. CLEVELAND 28, OHIO

American Felt TREATMENTS GREATLY EXPAND FELT'S FUNCTIONS

Just see this list of the treatments that can be given to felt by American. They tremendously increase the usefulness and value of felt, giving it new and added qualities and advantages. Especially treated felt from American may be the answer to one or more of your problems associated with either your production or your product. Remember that felt is an engineering material, which can be specified as accurately as any other. It can be had in rolls, sheets or cut or formed parts to your exact specifications. American's Engineering and Research Department will gladly collaborate with your engineers, designers and production men. Write on your company letterhead for:

Data Sheet No. 4, Special Felt Treatments.

American Felt Company

TRADE MARK

GENERAL OFFICES: 74 GLENVILLE ROAD, GLENVILLE, CONN.

SALES OFFICES: New York, Boston, Chicago, Detroit, Cleveland, Rochester, Philadelphia, St. Louis, Atlanta, Dallas, San Francisco, Los Angeles, Portland, Seattle, San Diego, Montreal.—PLANTS: Glenville, Conn.; Franklin, Mass.; Newburgh, N. Y.; Detroit, Mich.; Westerly, R. I.—ENGINEERING AND RESEARCH LABORATORIES: Glenville, Conn.

Felt Treatment Selection Chart

SIZING IMPREGNATIONS

TREATMENT INDEX	DESCRIPTION	TYPICAL USE
No. 1 Starch Base	Slight Stiffening	Coat Front Felts
No. 2 Starch Base	Medium Stiffening	Shoe, Tongue, and Pennant Felts
No. 3 Starch Base	Stiff Size	Millinery, Furrier, and Heel Pads
No. 4 Starch Base	Extra Stiff Size	Hat Brims
No. 5 Starch Base	Double Stiff Size	Carnival Hats
Starch Base	5% to 30% Dry Solids	Stiffening
Synthetic or Natural Resin Emulsions	5% to 30% Dry Solids	Permanent Stiffening—Pre-Form Molding

TREATMENT IMPREGNATIONS

Asphalt – Water Dispersed	Weather Sealing	Cowl Seals – Anti-Squeak Chassis Strips
Graphite – Water Dispersed	Lubrication	Anti-Friction Lubricating Pads – Washers – Oil Seals
Paraffin – Petrolatum (Cut Parts Only)	Waterproof Sealing - Lubrication	Float Valve Plunger Washers – Needle Lubricating Pads
Paraffin – Graphite - Petrolatum (Cut Parts Only)	Packing - Lubrication	Marine Stuffing Box Washers
Wax – Bee's - Carnarba - Candelilla - Paraffin (Cut Parts Only)	Blocking - Sealing	Polishing Laps – Waterproofing
Natural Latex, Hycar Latex, Neoprene Latex, Buna-S Latex	5% to 100% Dry Solids, Flexible Stiffening, and strengthening	Backing Felts, Cushioning, Type of Latex used dependent on conditions of use
Flame Resistance	Felt treated to specification will not propagate a flame	Aircraft and decorative felts, Clothes Dryer Felt
Fungi Resistance	Will not support fungus growth	As required by conditions of use
Flame and Fungi Resistance	Will not support Fungus Growth—Will not propagate a Flame	Felts for Acoustical and Thermal Insulation
Water Resistance	Minimum Water Absorption	Weatherstripping
Moisture - Fungi Resistance	Treated to Government Specification—Felt has Minimum Water Absorption and Will Not Support Fungus Growth	Tropicalization
Vermin Resistance	Felt non-attractive to insects	Musical or Scientific Instruments, Case Lining Felt
Moth Resistance	Resistant to carpet beetle larvae ravage	Musical or Scientific Instruments, Case Lining Felt

LAMINATIONS

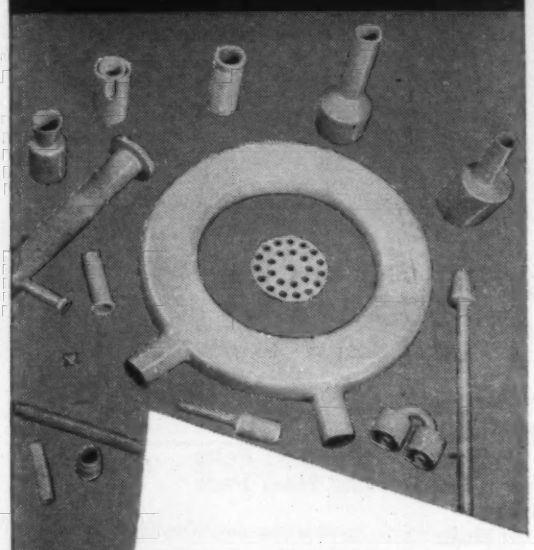
Hycar Sheeting, Neoprene Sheeting, Buna-S Sheeting	1/32" T and 1/64" T Impervious Septums Laminated to all Felt Densities	Oil or Water Seals, The Impervious Rubber Sheeting Functions As a Positive Dam
Hycar Rubber Vistex, Natural Rubber Vistex, Neoprene Rubber Vistex, Buna-S Rubber Vistex	A Sheet, Laminated, Felt Base Packing, Sealing and Gasketing Material	Fuel Pump Packing Washers, Mechanical Seals for Corrosive Liquids, Oil Wipers, Shock Absorber Packing
Aluminum Foil	Laminated to Pad Felts or Special "K" Felt	Reflectant, Acoustical and Thermal Insulating Blankets

COATINGS

Latex Rubber Surface Coating (One or Both Sides)	Reinforcement, non-skid	Reinforce low grade pad felts, non-skid typewriter pads, non-skid chair pads
Rubber and Starch Sizing Coating	Stiff Reinforcement	Window Channel Felt

McDANEL

HIGH TEMPERATURE PORCELAIN SPECIALTIES...



McDanel has been supplying quality Porcelain Products to the industrial companies of America for the past 30 years.

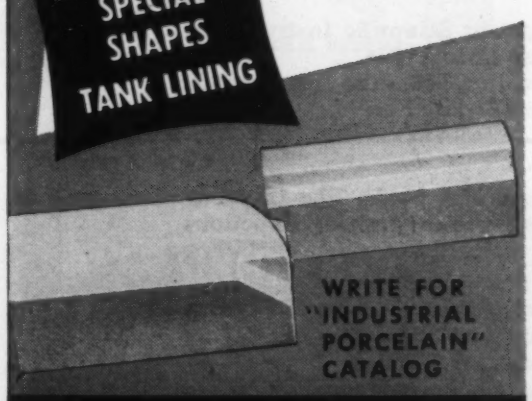
The McDanel Company not only fabricates parts to your specifications, but develops the proper porcelain body for the application you may have.

HIGH DENSITY MILL LINING

This High Density Lining is showing better than two times longer service over regular porcelain brick.

Mill Lining Brick and special shapes come in complete size range to fit every type mill.

MILL LINING SPECIAL SHAPES TANK LINING



McDANEL

REFRACTORY PORCELAIN CO.

BEAVER FALLS, PENNA.

News Digest

has also been announced by ACF. Mr. Euwer succeeds *Allen W. Clarke,* who is retiring after 46 years of continuous service.

Appointment of *Randolph W. Hyde* as assistant vice president and assistant treasurer of United States Steel Corp. has been announced.

V. H. Leichliter has been named vice president of operations of American Steel & Wire Div., United States Steel. Mr. Leichliter, who has been assistant vice president of operations since February 1950, succeeds *Walter F. Munford,* who assumed the presidency of the Wire Div. on Jan. 1. Official announcement has also been made of the appointments of *Wade B. Houk* as general superintendent of the Division's South Works; *Umbert F. Corsini* as general superintendent of the Steel & Wire Works of the Division in Donora, Pa.; and *John A. Slenker* as assistant vice president of operations.

Arnold I. Thorsen, works manager, Allis-Chalmers Manufacturing Co. Norwood Works, has been appointed assistant director of manufacturing for the company's General Machinery Div. *J. F. Costigan,* assistant works manager at Norwood, has been named the new works manager, replacing Mr. Thorsen. Appointment of *Arthur F. Erwin* and *Edward F. Brill* as manager and chief engineer, respectively, of the company's Atomic Power Section has also been announced.

F. L. Bryant has been named superintendent for the Niagara Falls plant of Hooker Electrochemical Co. and *J. D. Sweeney* has been named as assistant superintendent of production. *R. Lindley Murray,* president of the company, has been awarded honorary membership in the American Institute of Chemists, according to another company announcement. Mr. Murray is the 46th recipient of honorary membership in the Institute since its founding in 1924.

Appointment of *George B. McMeans* as vice president in charge of operations for Kaiser Steel Corp. has been announced.

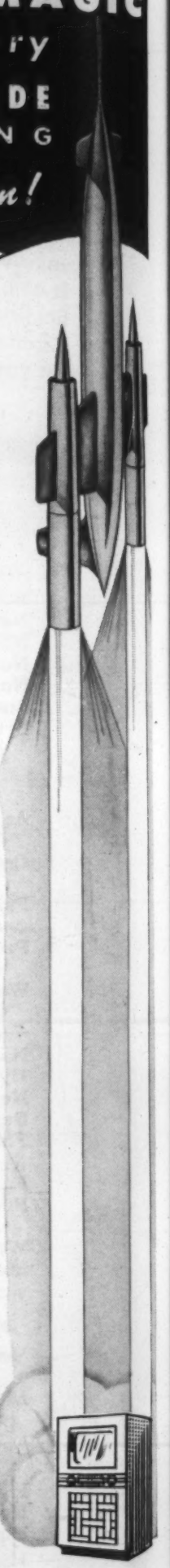
Marshall W. Acker, a vice president and director of Olin Industries, Inc., has retired from active service as general manager of the Metals Div. Mr. Acker will be succeeded by *M. F. Meissner,* who has been his assistant.

Eaton Manufacturing Co. has announced the appointment of *Samuel H. Wood* as manager of the Marion Forge Div. plant now under construction in Ohio Mr. Wood joins Eaton after 18 years as chief engineer with Timken-Detroit Axle Co.'s Forge Div.

Edward G. Petherick recently retired after 25 years with Norton Co. as an abrasive engineer.

New Jersey Zinc Co. has announced the appointment of *David L. Gamble* as man-

BLACK MAGIC meets every BLACK OXIDE FINISHING Specification!



BLACK MAGIC — whether applied to civilian or defense production — has proved to be a versatile, economical finish. Its ability to blacken heat treated parts or previously "hard to blacken" items has established BLACK MAGIC as a finish capable of exceeding black oxide requirements.

Other advantages are:

- ★ One Bath—One Salt
- ★ Lower Operating Temperature
- ★ Self Rectifying
- ★ Faster Blackening Cycle
- ★ More Corrosion Resistant

★

MEETS GOVERNMENT SPECIFICATIONS

57-0-2C type 3; 51-70-1A Finish 22.04; Aeronautical Material Specifications AMS2485

★

A comprehensive study of the application of a black oxide finish has been compiled and is now available in our latest catalog. Write for your complimentary copy today.

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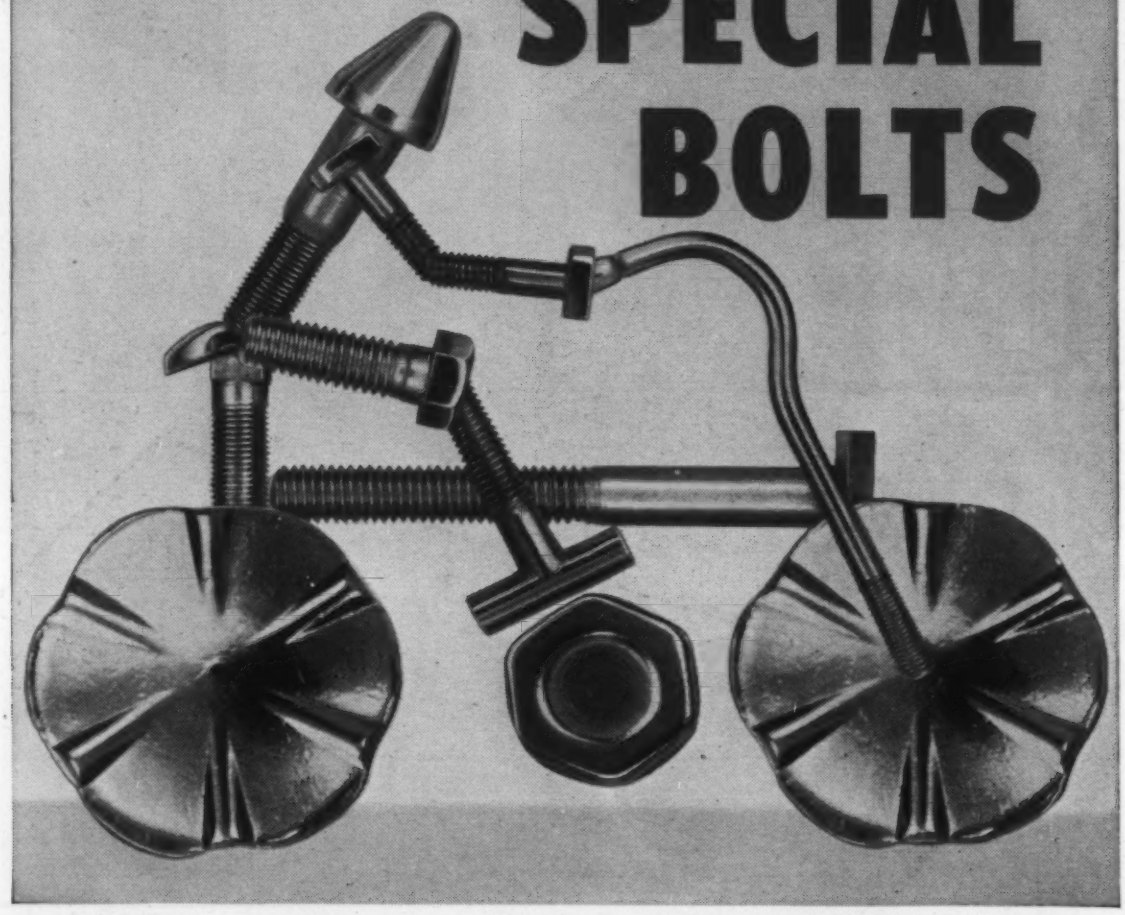

●Why limit the design of your products to ordinary fasteners? Special Circle Ⓑ bolts can often add sales appeal in improved design with greater strength. Equally important, you can figure on faster, easier assembly at lower unit cost. Call on our experience to gain plenty of practical advantages.

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News Digest

ager of research to succeed *George F. A. Stutz,* who has been transferred to the New York office as development engineer. *Robert K. Waring* was advanced to assistant manager of research, the position formerly held by Mr. Gamble.

The appointment of *Irving T. Bennett* as vice president in charge of manufacturing of Revere Copper and Brass Inc. has been announced. Mr. Bennett, who was vice president in charge of the Baltimore and Aluminum Divs. of Revere, has been moved to New York where the company's executive offices are located.

Everett N. McDonnell, president of McDonnell & Miller, Inc., has been selected to receive the 1952 F. Paul Anderson Medal of the American Society of Heating and Ventilating Engineers "for outstanding work in the field of heating, ventilating and air conditioning".

William L. Swager, a member of the staff of Battelle Memorial Institute since 1948, has been named to supervise and coordinate Battelle's expanding work in operations research. He will be responsible for the application of scientific techniques and engineering methods to the operational problems of both industry and the military services.

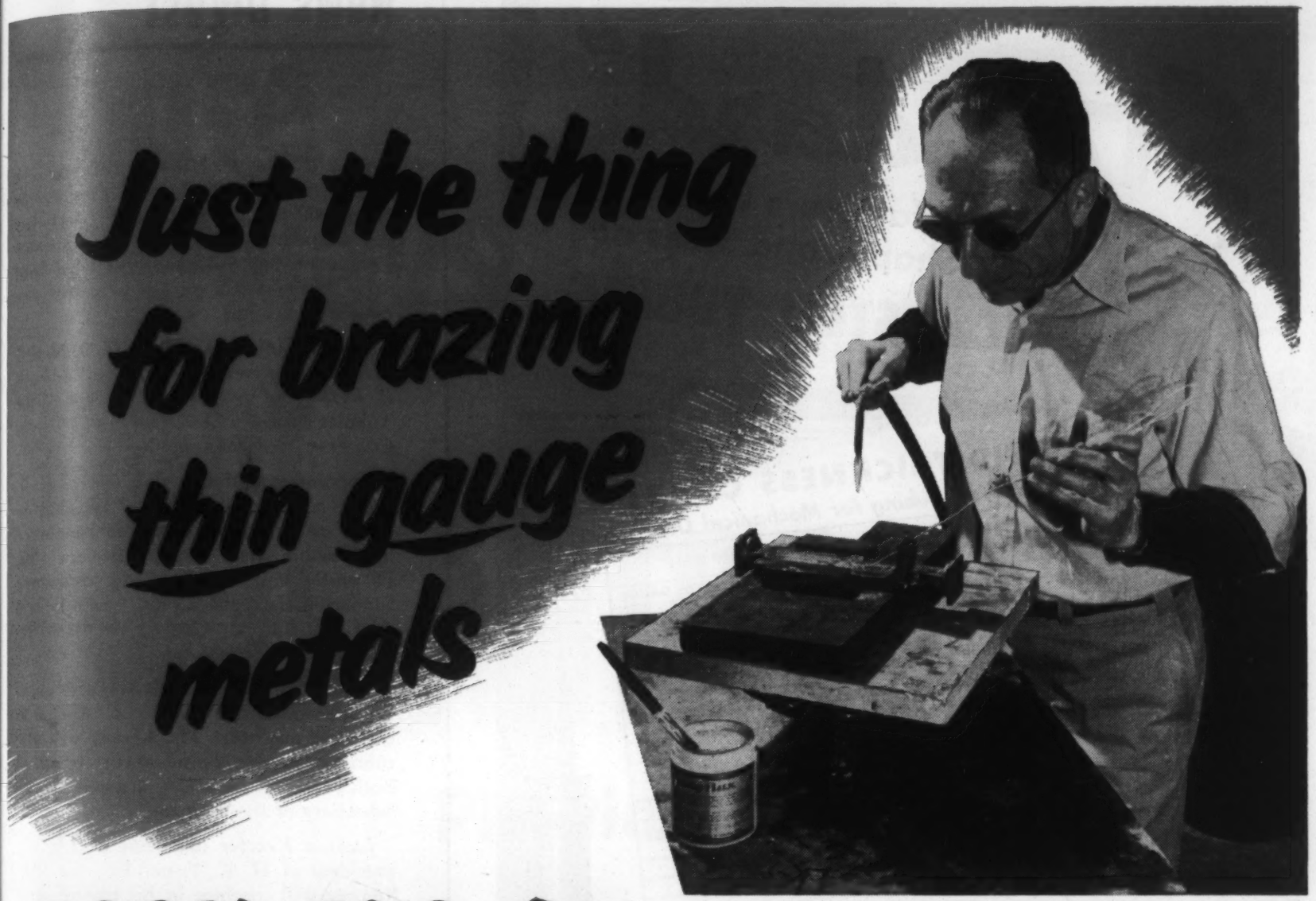
Four Aluminum Co. of America Casting Div. employees have been named to higher posts: *Sanford H. Bennett* has been named chief industrial engineer; *H. E. Cook,* superintendent of the Buffalo Works, will succeed Mr. Bennett as works manager at Buffalo; *Norbert C. Hilbrecht,* chief industrial engineer of the Buffalo Works, has been named superintendent of that Works; and *Sherwood Willard* has been named to the post vacated by Mr. Hilbrecht.

Warren E. Scoville, Jr. has been appointed assistant manager of the Development Dept. of U. S. Rubber Co.'s plant in Passaic, N. J.

Effective Jan. 1, the Engineering Div. of the Gulf Research & Development Co., the research organization of Gulf Oil Corp., was divided into two new divisions: Engineering, and Automotive Engineering. *E. Topanelian, Jr.* has been appointed director of engineering, with *Bruce R. Walsh* as assistant director of engineering. *J. Edward Taylor,* formerly a member of the Product Development and Product Engineering Dept., has been transferred to the Research Dept. as director of automotive engineering, and will have *Charles R. Butler* and *R. L. Kirkpatrick* as assistants.

The appointment of *O. N. Marquardt* as manufacturing manager of the TOCCO Div., Ohio Crankshaft Co., has been announced.

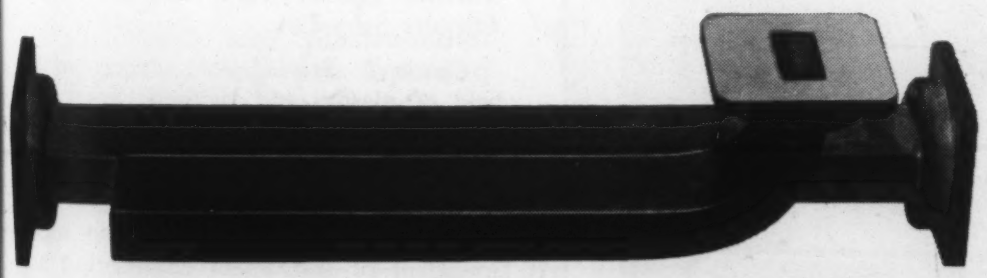
The following promotions have been announced by Eutectic Welding Alloys


Just the thing
for brazing
thin gauge
metals

EASY-FLO 45

With its low working temperature of 1145° F, EASY-FLO 45 is just what the doctor ordered for joining thin gauge metals. It brazes them without danger of damage from overheating. The low flow point also cuts a big chunk off heating costs.

And here are more good reasons why this silver brazing alloy is so widely used for joining thin gauge metals. EASY-FLO 45 is exceptionally free flowing. Because of this it penetrates into and over the entire joint area the instant its low flow point is reached. Results—high strength, liquid and gas tight joints—joints so clean they seldom need finishing. Here's a sample — a directional coupler from the line of microwave test equipment made by the Polytechnic Research & Development Co. Inc., Brooklyn, N. Y.



Curved and straight sections of rectangular brass tubing are brazed along a common side wall and flanges are attached with 1/16" EASY-FLO 45 wire. Bodies are finished with baked gray enamel and flanges are nickel plated. The clean EASY-FLO 45 joints greatly facilitate finishing.

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Serves Manufacturers Who Use All Shapes and Sizes of

MECHANICAL STEEL TUBING

SIZE AND THICKNESS CHART

of Electric Weld Tubing for Mechanical Use

TUBE DIAMETER *O.D. SIZE	MAXIMUM WALL		MINIMUM WALL	
	DECIMAL	B. W. GAUGE	DECIMAL	B. W. GAUGE
1/2"	.065"	16	.028"	22
5/8"	.065"	16	.028"	22
3/4"	.065"	16	.028"	22
7/8"	.083"	14	.028"	22
1"	.109"	12	.028"	22
1-1/8"	.109"	12	.028"	22
1-1/4"	.134"	10	.028"	22
1-3/8"	.134"	10	.028"	22
1-1/2"	.148"	9	.035"	20
1-5/8"	.148"	9	.035"	20
1-3/4"	.148"	9	.035"	20
1-7/8"	.165"	8	.035"	20
2"	.165"	8	.035"	20
2-1/4"	.180"	7	.035"	20
2-1/2"	.203"	6	.035"	20
2-3/4"	.203"	6	.035"	20
3"	.220"	5	.049"	18
3-1/4"	.220"	5	.049"	18
3-1/2"	.238"	4	.049"	18
3-3/4"	.238"	4	.049"	18
3-7/8"	.238"	4	.049"	18
4"	.238"	4	.049"	18
4-1/4"	.250"	3	.049"	18
4-1/2"	.250"	3	.065"	16
4-3/4"	.250"	3	.083"	14
5"	.180"	7	.083"	14
5-1/2"	.180"	7	.083"	14

*Intermediate sizes within the range indicated can also be manufactured. Please consult us for sizes not listed.

Manufacturers requiring tubing for civilian or defense production prefer "Standard's" Electric Weld Steel Tubing for many reasons! "Standard's" Electric Weld is produced in one of the most versatile and complete mills of its kind in the world. "Standard's" 33 years of specialized tubing "know-how", and monthly production of millions of feet of stainless and carbon steel tubing, in wide range of sizes and gauges, assure you of utmost satisfaction. No problem of tolerance, precision or severest application for mechanical, structural, or pressure tubing is too difficult.

STAINLESS STEEL TUBING
⅛" to 3" O.D. . . . .028 to .095 wall

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Detroit 28, Michigan

Welded Tubing — Fabricated Parts

STANDARDIZE with STANDARD — It Pays

News Digest

Corp.: *Walter R. Hillman* has been appointed assistant to the vice president in charge of production; *Joseph Quaas* has been appointed manager of the Electrode Production Div.; *Andre Jaccard* has been appointed assistant to the executive vice president.

The appointments of *Harold D. Newell* as consulting metallurgist and of *John J. B. Rutherford* as chief metallurgist of the Tubular Products Div., Babcock & Wilcox Co., have been announced.

Appointment of *David I. Dilworth, Jr.* to the newly created post of assistant director of metallurgy has been announced by Crucible Steel Co. of America. Mr. Dilworth moves up from the company's Sanderson-Halcomb Works, where he was chief metallurgist. *Eugene A. March* replaces Mr. Dilworth.

Vapor Heating Corp. has announced the appointment of *William C. Keeran* as executive engineer. Mr. Keeran will also continue as vice president in charge of Roth Manufacturing Co., a wholly-owned subsidiary of the company.

Jackson Kemper has been elected vice president of H. K. Porter Co., Inc. Mr. Kemper will continue in his present capacity as general manager, Watson-Stillman Fittings Div. of the company.

Dr. *Robert W. Cairns*, assistant director of research for Hercules Powder Co., has been named vice-chairman of the Research and Development Board, which is a staff agency of the Secretary of Defense.

Dr. *Philip R. Marvin* was recently named vice president of Commonwealth Engineering Co.

Appointment of *Carl J. Demrick* as staff master mechanic of Chrysler Corp. has been announced. Mr. Demrick succeeds *M. T. O'Donnell,* who has been named assistant general works manager of the Chrysler Sales Div.

Calvin E. Schildknecht, expert in the field of plastics and synthetic fibers, has joined the faculty of Stevens Institute as an associate professor in the Chemistry Dept.

Promotion of *John D. Harby* to superintendent of instrument engineering and of *J. Donald Dutcher* to superintendent of instrument manufacturing, has recently been announced by Bausch & Lomb Optical Co.

Kenneth R. Brock, former general manager of McGuire Pontiac, has been named vice president of the OK Stamping Corp.'s newly acquired plant in Toledo, Ohio. In addition, he has been appointed assistant general manager of the Nash Manufacturing Co. in Toledo.

The following appointments have been announced by National Research Corp:

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• Plastics and plastic-metal combinations are opening new fields in design as illustrated by these few of many assemblies made by Auto-Lite. Here under one roof at Auto-Lite's great Bay Manufacturing Division in Bay City are the technical skills and production capacity for a new art rendered in plastics. The artistic skill of Auto-Lite's Art and Style Division is available on matters of design and development. Address inquiries to:

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News Digest

John L. Ham has been named project manager in the Metallurgical Dept.; *Kenneth G. Donald* has been appointed vice president and treasurer of the corporation; Dr. *Milo P. Hnilicka, Jr.* has joined the Chemistry Dept.

Samuel Sloan Auchincloss has been elected president of DeWalt Inc., according to a recent announcement.

After 26 years of service at the National Bureau of Standards, *Harold E. Cleaves* has retired as chief of the Chemical Metallurgy Section.

New appointments in various divisions of Kaiser Aluminum & Chemical Corp. have been announced: *Ralph E. Knight*, formerly assistant general manager, Chemical Div., has been promoted to a vice presidency and will assume the duties of director of research and development for the Aluminum and Chemical Divs.; *W. R. Woodman*, formerly manager of the Chemical Div.'s operations, has been named manager of the Aluminum Div.'s raw material operations.

Peter Budd Tursi has been named chief metallurgist, The Riverside Metal Co., according to a recent company announcement.

John W. Mazur, recently with the Naval Air Test Center, Patuxent, Md., has joined Doman Helicopters, Inc. as chief design engineer.

The Hydraulic Press Manufacturing Co., has announced the promotions of *William H. Bennett* to director of engineering, and of *H. J. Zilske* to chief engineer.

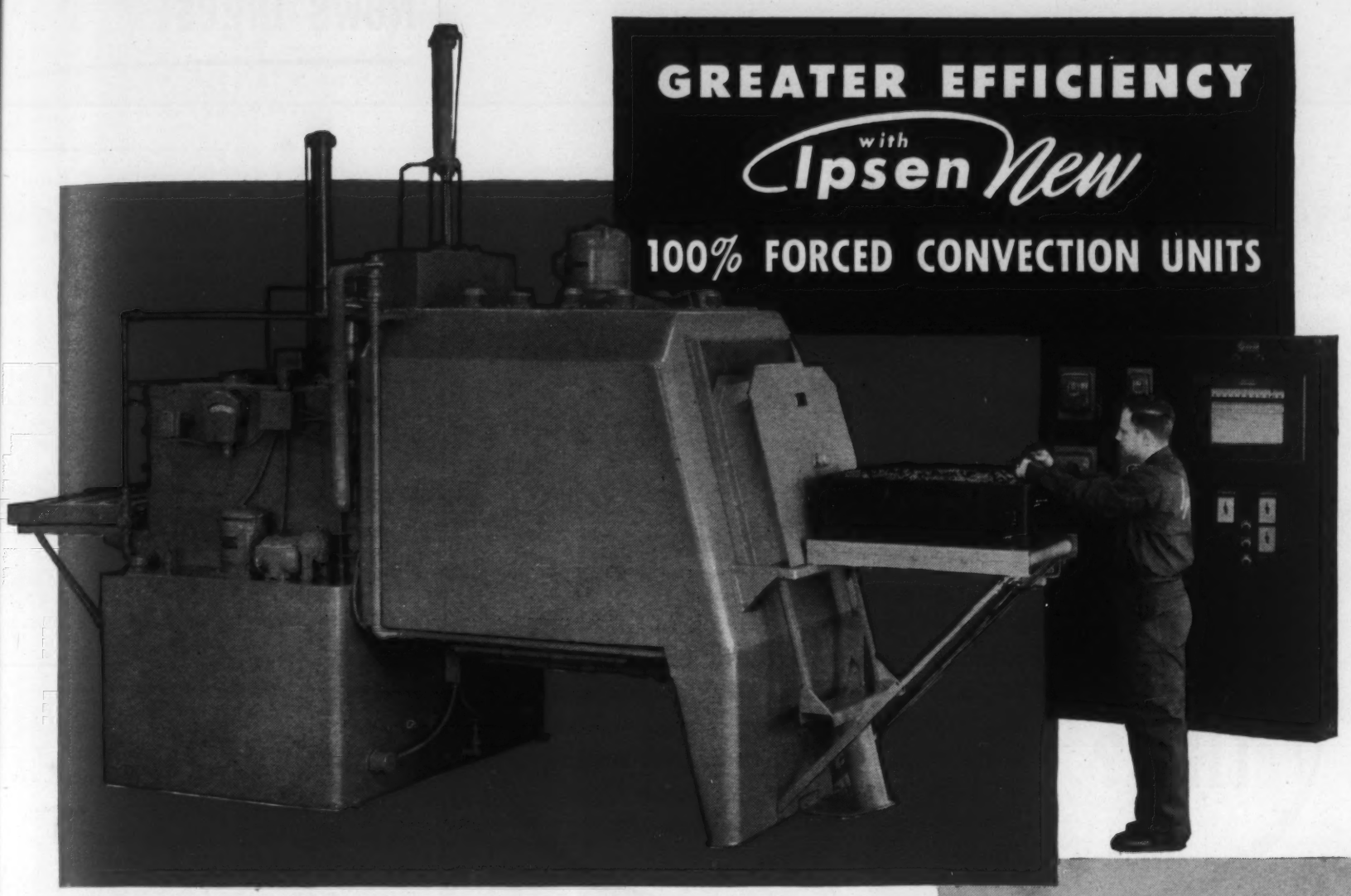
Chain Belt Co. has announced the appointment of *Luther H. Bosnian* as vice president in charge of manufacturing facilities, and of *Bernhard G. Schneider* to the newly created post of assistant chief engineer, Conveyor Equipment Section of the Conveyor and Process Equipment Div.

Dr. *Cyril G. Veinott*, electric motor design engineer, inventor and author, has joined the Reliance Electric & Engineering Co. as consulting engineer on a.c. machinery.

Dr. *Gordon K. Teal* has joined Texas Instruments Inc. as assistant vice president and director of the Materials and Components Research Dept. of the Engineering Div.

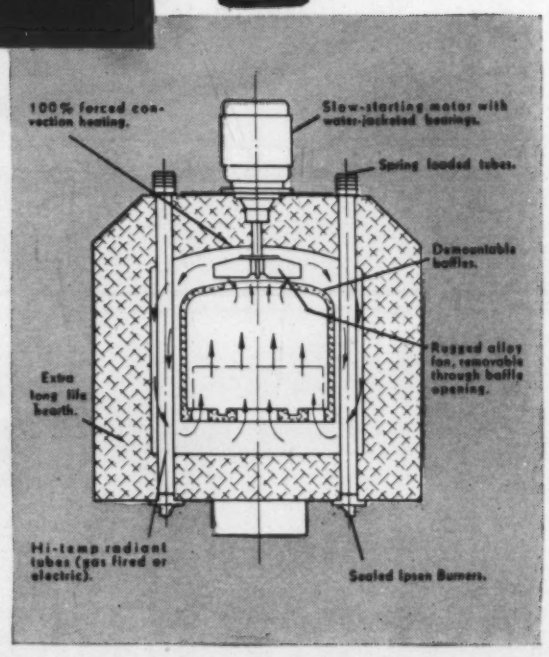
O. W. Acheson has recently been appointed manager of manufacturing for Lamson Corp. Mr. Acheson was general manager of the Allen Billmyre Corp. prior to its purchase by Lamson.

At a recent board of directors meeting of Raybestos-Manhattan, Inc., the following appointments were made. *W. Ward Kievit*, treasurer, succeeding *George R. Weber*, recently deceased; *William S. Simpson*, general manager of the division



▲ *New Ipsen 400 Lb./Hr. Automatic Heat Treating Unit equipped for martempering. Straight-through operation from heat through quench, or cooling, eliminates loading delays.*

▶ *Ipsen's new radiant tube and 100% forced convection heating design. Spring-loaded tubes seal automatically. Controlled atmosphere throughout assures bright, clean, scale-free work.*


100% forced convection heating.
Slow-starting motor with water-jacketed bearings.
Spring loaded tubes.
Demountable baffles.
Rugged alloy fan, removable through baffle opening.
Extra long life hearth.
Hi-temp radiant tubes (gas fired or electric).
Sealed Ipsen Burners.

Ipsen controlled atmosphere heat treating units are designed with 100% forced convection heating to provide greater efficiency. Built for temperatures up to 1850° F., they can profitably handle a wide range of work, both in small lots and in production runs.

These are some of Ipsen's outstanding design features which will give you greater efficiency in processing:

1 **100% Forced Convection Heating**—powerful alloy fan forces atmosphere around radiant tubes, under floor, and *through* the work. Provides faster heat recovery and uniform circulation. Fan is removable through baffle opening in hearth.

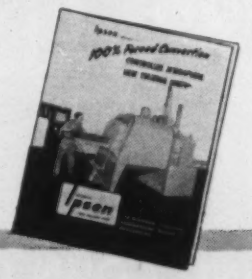
2 **Long Life, Radiant Tubes** — withstand high temperatures, assure long, trouble-free service. Light in weight, are easier to remove, cost 50% less to replace.

3 **New Sealed-in Silent Burners**—provide accurate flame control, fast temperature buildup, *complete* combustion and uniform temperature.

4 **Demountable Baffles** — assure complete circulation of atmospheres through the load and maintain uniform work temperature. Sectional-type construction permits easy replacement. Complete unit can be removed in ten minutes.

Send **Samples for Free Estimate** — find out how the new Ipsen Units can be applied to your job. Samples of your work will be run, procedures established in our new, modern lab, and cost estimates given without obligation.

Write **for New Literature** — illustrates new design features, gives complete specifications of various units.



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In line with our specialization in wire for new applications, we produce wires of composition suitable for the manufacture of Transistors; including GALLIUM GOLD and ANTIMONY GOLD. These alloys have been made to fill a specific need arising from new developments in this field.

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Other wires we make regularly for similar application are PHOSPHOR BRONZE, bare or electroplated, and PLATINUM Alloys produced to meet rigid specifications of tensile strength, size and straightness.

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SINCE 1901

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News Digest

at Stratford, Conn., succeeding *Robert B. Davis*, recently retired; *Osborn H. Cilley*, general manager of the U. S. Asbestos-Grey-Rock Div., succeeding *George R. Weber; S. R. Zimmerman, Jr.*, assistant general manager of the U. S. Asbestos-Grey-Rock Div.

Appointments of *Alexander Ross* as chief engineer and *H. R. Sennstrom* as executive engineer have been announced by American Locomotive Co., Locomotive Div.

Philip Del Valle has been named plant manager, Synchro Div., Beckman Instruments, Inc.

Herbert J. Wettlaufer has been named vice-president of the Wettlaufer Manufacturing Corp.

The death of *Charles H. Currier*, chairman of the board of Kewanee-Ross Corp., has been announced by the company.

Carl D. Fischer, Jr., president and general manager of the Wapakoneta Machine Co., died recently after a 2-year illness.

The death of *Walter L. Maxson*, vice president-research, for the Oliver Iron Mining Div., United States Steel Corp., has been announced.

Frank M. Mason, vice president of United States Electrical Motors, Inc., recently died of a heart attack.

Raybestos-Manhattan, Inc., has announced the death of *George R. Weber*, vice president, treasurer and a director of the company.

Dr. *Charles Holmes Herty, Jr.*, assistant to the vice president of Bethlehem Steel Co.'s Steel Div., died suddenly on January 17th.

News of Companies

The Air Force has approved the construction of a million-dollar addition to the *General Electric Co.'s* plant near Johnson City, N. Y. The new building will be used for complete controlled testing of aircraft armament systems being built for the Air Force by G-E.

Expansion of *du Pont's* titanium sponge producing facilities is now under way at its Newport, Del., plant and is scheduled to begin shortly at its Edge Moor, Del., plant, according to recent company reports.

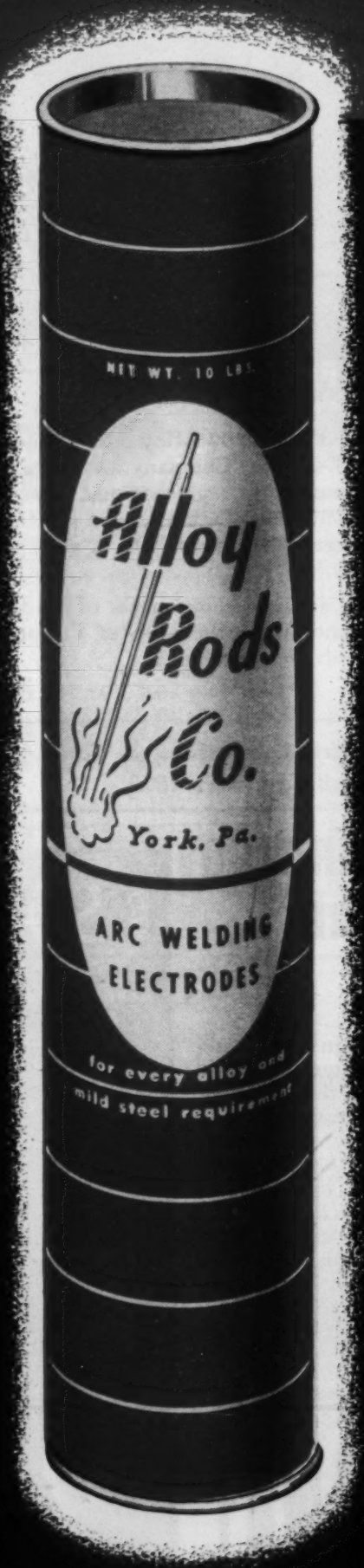
American Research Corp., 11 Brook St.,

Welders everywhere will tell you there are NO FINER ELECTRODES MADE... ANYWHERE!

ARCALOY stainless steel electrodes for every stainless steel welding requirement. Lime coating for all-position welding, reverse polarity. AC-DC coating for chrome-nickel steels with all types of AC or DC welding equipment. Twenty-three regular analyses, plus several special analyses. *Write for Bulletin 5751.*

BRONZE-ARC phosphor bronze electrodes for all-position welding with reverse polarity on DC. Smooth, easy-flowing arc eliminates any erratic arc action. Makes superior low-spatter, dense, porosity-free, high-strength welds on bronze, brass, copper . . . excellent to join dissimilar metals. *Write for Bulletin AR53-1.*

NICKEL-ARC, NICKEL-ARC 60 electrodes for cast iron. Nickel-Arc 60 is the finest electrode available today for cast iron welding. Like the well-known Nickel-Arc, it has a smooth arc and spatter-free action with AC or DC. Soft machinable deposit is ideal for repairing broken or worn castings. *Write for Bulletin 2218.*



TOOL-ARC electrodes for tools and dies weld each of the five basic types of tool and die steels including: oil hardening, hot work, water hardening, high speed, and air hardening . . . also for work hardening applications. Conserves material, saves man hours, and minimizes production delays. *Write for Bulletin AR52-1.*

WEAR-ARC hard-facing electrodes for fast, economical, efficient rebuilding and hard-facing to resist abrasion, impact, compression, corrosion, and heat. Nine basic types for correcting specific wear patterns, reclaiming worn equipment and parts, guarding against future wear. *Write for Bulletin 5651.*

WELD-ARC low hydrogen electrodes for welding high carbon, high sulphur, free machining, and other difficult-to-weld steels, with AC or DC. Low spatter loss, high deposition efficiency, very quiet arc action, free from tendency to undercut, welds free from under-bead cracking. *Write for Bulletin AR51-1.*

Alloy Rods Co.
LOOK FOR THE FLAMING ARC TRADEMARK

AR-11

Packaged in the familiar Alloy Rods red and yellow all-metal moisture-proof containers, every rod reaches you in "oven fresh" condition.

ALLOY RODS COMPANY
YORK, PENNSYLVANIA

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WESTERN PREMIERE • Alloy Rods' 22-minute sound-color film "No Finer Electrodes Made . . . Anywhere"—Alloy Rods' Exhibit, Western Metal Exposition, Space 105, Pan-Pacific Auditorium, March 23-27, 1953.

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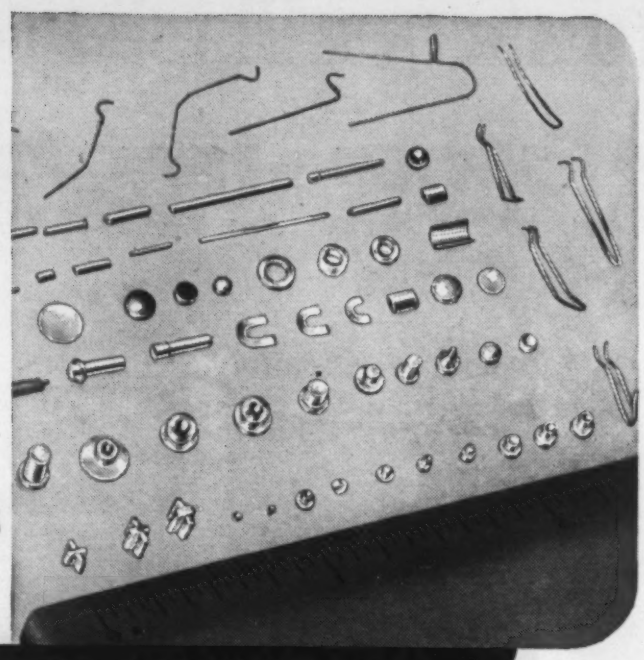
PRECIOUS METAL ALLOYS AND COMPLETE ASSEMBLIES



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Parts fabricated from Ney's Precious Metal Alloys are now components of instruments used in navigation, recording, computing, and many other devices. Consult the Ney Engineering Department for assistance with your problems.

*Reg. Trade Mark J. M. Ney Co.

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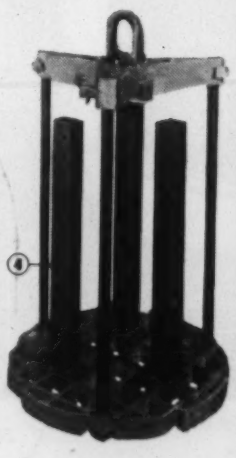
THIS STANWOOD CARBURIZING AND QUENCHING FIXTURE

has more lives than a cat!

DURABLE design and construction materials that will see it through the furnace time after time. Any part can be replaced separately. Posts are passed through slotted holes in grids (1) then given a half turn to lock grid in place. Yoke (2) is keyed onto posts. Lifting hook (3) is keyed on. Any number of grids or shelves available.



Bottom grid is available with tubes (4), 1" dia. up, perforated to overcome "gusher action" in quenching. Parts such as spiders, ring gears, and collars can be slipped over tubes for secure handling. Also types with spacers to support shafts. Send for literature.

Stanwood Corporation

4813 W. Cortland St., Chicago 39, Ill.

News Digest

Bristol, Conn., started operation Feb. 1 for the design and manufacture of environmental test equipment. Thomas J. Lopiccolo is president of the new company.

The General Engineering Co. Ltd., Toronto, Canada, announced the opening of *GECO Inc.*, with offices at 431 Bulkley Bldg., 1501 Euclid Ave., Cleveland.

Apex Smelting Co. has announced the formation of the *National Metallurgical Corp.* to construct and operate its pilot plant at Springfield, Ore. for the production of aluminum-silicon metal from clays. The *American Smelting & Refining Co.* has acquired a half interest in the new corporation. Officers will be: W. A. Singer, president; R. D. Taylor, vice president; R. K. Beck, vice president; L. Lippa, secretary and treasurer.

American Wheelabrator & Equipment Corp. has just completed construction of a new plant specially designed for the manufacture of Wheelabrator Steel Shot, a new blast cleaning abrasive produced under the company's patented process.

A new laboratory providing complete facilities for testing and developing materials, equipment and processes for customers has just been opened at the *F. J. Stokes Machine Co.*, Philadelphia.

The Dynakon Corp. has announced the acquisition of new and larger facilities in the Cleveland area. The new plant is said to have several times the floor space, separate laboratory building, and ample land for expansion.

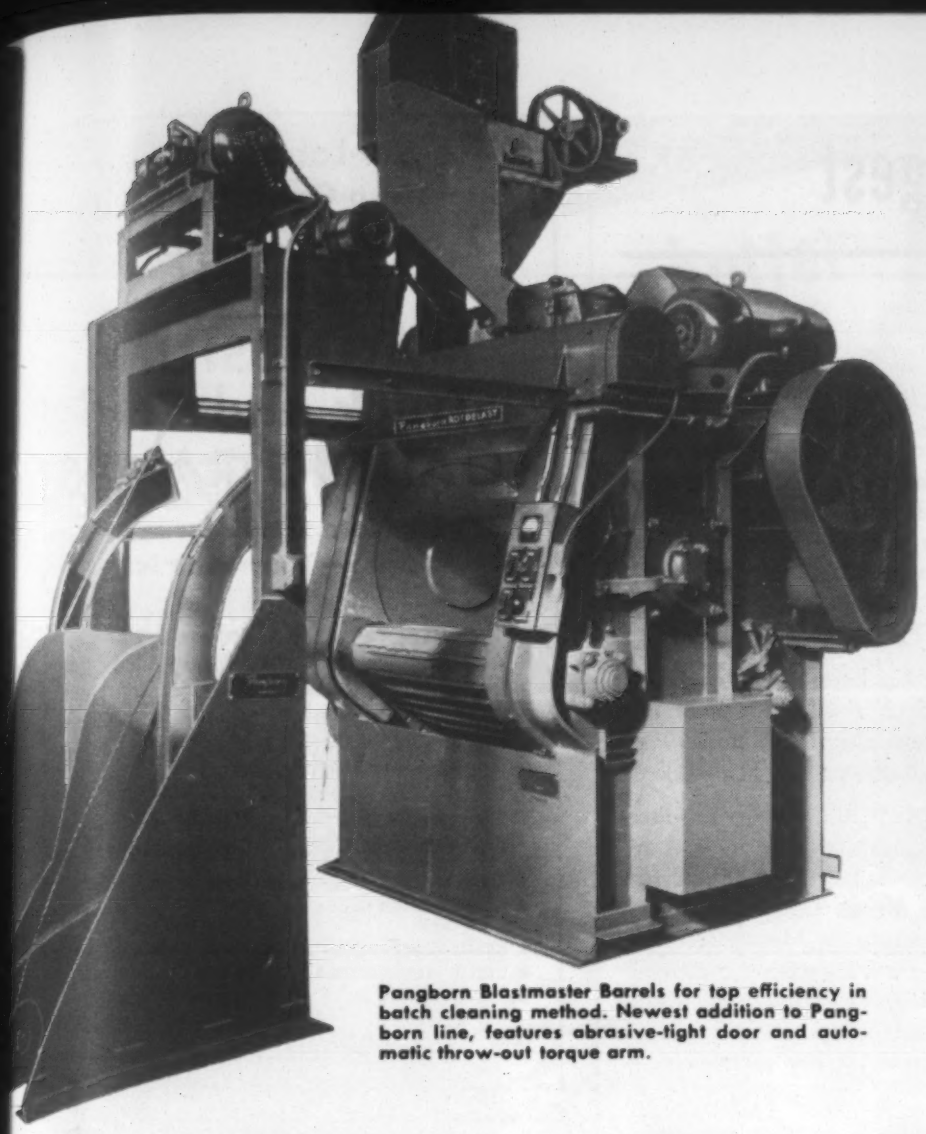
Formation of a *General Research Organization* for *Olin Industries, Inc.* The General Research Organization will conduct basic research and work with all eight Olin manufacturing divisions on long range and specialized research problems. Laboratories already have been established at New Haven, Conn., and East Alton, Ill.

New, modern research facilities for *Arthur D. Little, Inc.* will be erected on the Concord Turnpike, West Cambridge, Mass., and will be ready for occupancy by the end of the year, according to a recent company statement.

Official ground breaking ceremonies were recently held for the *American Cam Co.'s* new plant in Bloomfield, Conn. The new building, which will cost $100,000, will be completed about May 1 of this year.

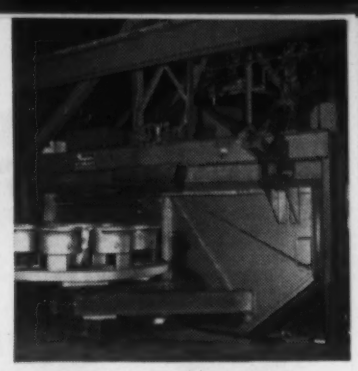
As of Jan. 1, 1953, the plants and facilities of *John A. Roebling's Sons Co.* have been operated as a wholly-owned subsidiary of *The Colorado Fuel and Iron Corp.* under the name of *John A. Roebling's Sons Corp.*

The formation of *Park Rubber Co., Inc.* with offices and plant at Lake Zurich, Ill., has been announced. The new company is

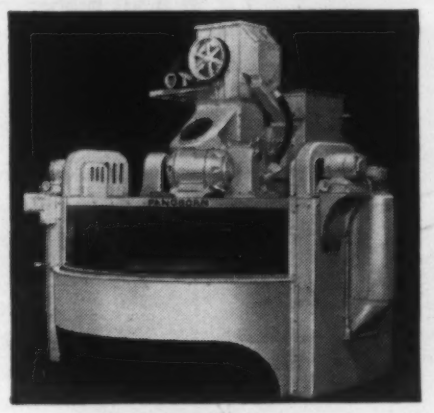


Pangborn Blastmaster Barrels for top efficiency in batch cleaning method. Newest addition to Pangborn line, features abrasive-tight door and automatic throw-out torque arm.

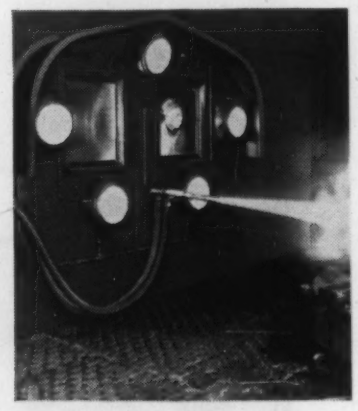
Pangborn ROTOBLAST® Table-Rooms clean castings from a few pounds to 2½ tons. Extremely efficient for jobbing foundries. For all-purpose blast cleaning.



Pangborn Turnstyle Tables allow simultaneous loading and cleaning as one of two tables is always in blast chamber. For general blast cleaning.



Pangborn ROTOBLAST Tables for semi-continuous blast cleaning. Types and sizes for castings of all sizes with deep pockets, intricate shapes, and many surfaces.



Pangborn Hydro - Sand Blast Rooms for simultaneous blast cleaning and core removal. Use high-pressure stream of sand and water operated from outside.

Pangborn Airless ROTOBLAST Rooms for general blast cleaning of extra-large castings. Neither compressed air nor water is necessary. Operated from outside.

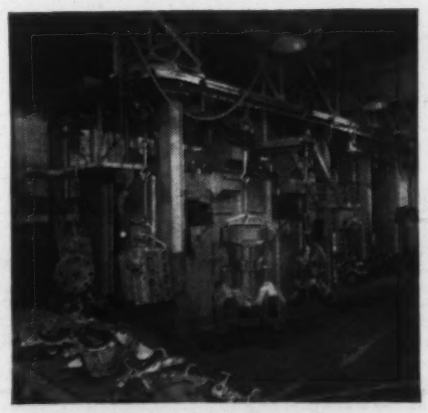
8 Ways Pangborn Saves Industry and You--Time, Labor and Money

Here are just eight of the many types of standard Pangborn Blast Cleaning and Dust Control machines serving industry. For nearly half a century, Pangborn engineers with "know how" have been helping foundries save time, labor and money with these units as well as with specially-designed machines.

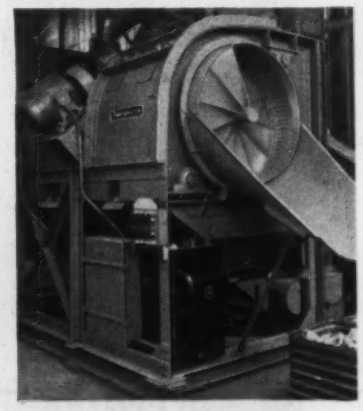
These engineers can do the same for *you!* They'll be happy to work closely with you, in recommending the exact Pangborn units you need, and in developing new equipment when necessary. No matter what you clean—large or small castings, fragile or intricate molds, or any combination . . . no matter what your dust problem, if dust must be collected at the source . . . it will pay you to find out how Pangborn can help you.

Send for the Pangborn bulletins that fit your needs. Just fill out the coupon below and mail to: PANGBORN CORPORATION, 1700 Pangborn Blvd., Hagerstown, Maryland.

OVER 28,000 PANGBORN MACHINES SERVING INDUSTRY



Pangborn special equipment for unusual blast-cleaning problems. Designed only after careful study by Pangborn engineers skilled in such problems.



Pangborn Continuous-Flo ROTOBLAST Barrels for cleaning steady flow of miscellaneous work quickly. Operated by one man on production line basis.

Pangborn

Look to Pangborn for the latest developments in Dust Control and Blast Cleaning equipment

BLAST CLEANS CHEAPER

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Name ----------

Company ----------

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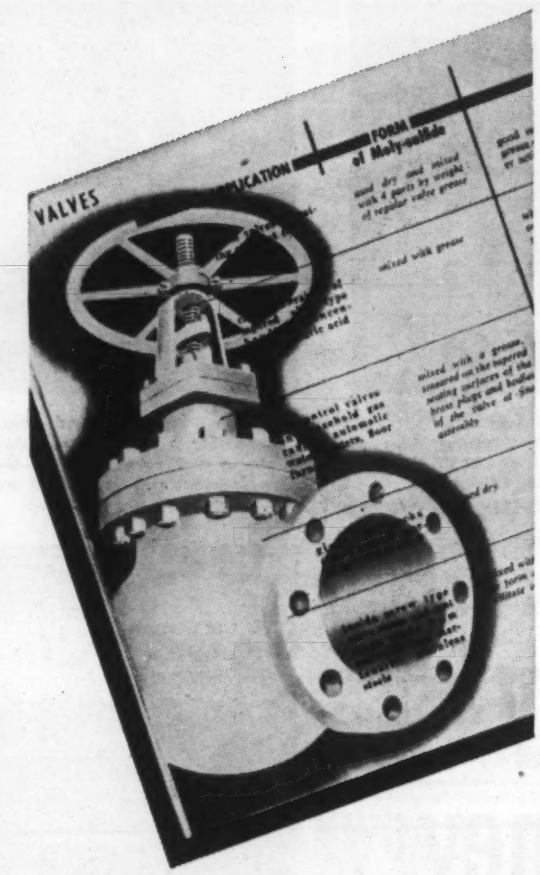
Moly-sulfide
A LITTLE DOES A LOT

is proving effective even where other lubricants have failed



Moly-sulfide, a solid-film lubricant, is proving so useful in difficult friction applications that new uses are found daily. 154 cases of how serious problems were solved are described in our booklet. Your own problems may be like those described. Write for your copy of this booklet.

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MOLY

MM-3 MS-8A

News Digest

the result of a merger between *Rubber Engineering and Chemical Co.* and *Park Rubber Corp.* Products of the new company will be principally molded mechanical rubber goods and clicking machine pads and blocks for the shoe industry. Officers are: George M. Field, Jr., president; Robert T. Duffy, Jr., Henry J. Droba and Fred Fuller, vice presidents.

Announcement has been made by *American Nail and Metal Products Co.* of the opening of its new aluminum nail plant at 1230 M-28 W. Lisbon Ave., Milwaukee.

A $2,500,000 plant, the first to produce zirconium and hafnium metals in a commercial operation, is being designed for the *Carborundum Metals Co., Inc.*, at Akron, N. Y. Carborundum Metals recently signed a five-year contract with the *Atomic Energy Commission* for delivery of 150,000 lb of zirconium and hafnium sponge metals from the new facility each year.

A new modern structure built almost entirely of stainless steel and glass has been erected by *Edward Valves, Inc.*, East Chicago, Ind. The new building is located next to the Edward laboratory and research building, and was built for the use of the Engineering Dept.

Columbia Tool Steel Co. recently held an open house for guests and members of the Calumet Chapter of the American Society for Metals. The group made a 2-hr. conducted tour of the Columbia plant.

Dow Chemical Co. has started construction on a plant at Torrance, Calif., for the manufacture of Styron, a polystryene plastic material. Facilities will include equipment for the manufacture of plastic granules in a variety of colors in addition to clear, uncolored material.

Continental Can Co.'s Conolite (laminated plastics) operations, formerly a part of the Plastics Div. in Cambridge, Ohio, will be taken over by the *Bond Crown and Cork Co.*, a wholly-owned subsidiary, and transferred to Milwaukee.

Grieve-Hendry Co., Inc. has moved into a larger modern factory at 1811-19 W. Lake St., Chicago 12.

Purchase of the *Rome Machinery Sales and Engineering Co.* has been announced by *Engelberg Huller Co., Inc.*

Effective Jan. 1, *Rolled Products Div., Michigan Steel Casting Co.*, became an independent company, *Rolled Alloys, Inc.* Rolled Alloys, Inc. is located at 4815 Bellevue Ave., Detroit 7. All personnel formerly connected with Rolled Products Div. are now with the new company.

Purchase of the *Eagle-Picher* paint plant in Atlanta, Ga., by the *Glidden Co.*, and plans for doubling its capacity have been announced.

The engineering facilities of the *Piping*

Cut Labor Costs
Speed-up Operations with
PENCO

MAGNESIUM Truck and Car LOADING RAMPS

220 Standard Sizes — Thousands in Use

Penco lightweight Magnesium Ramps are your answer for 100% loading and unloading dock operations. There is a Penco style and size for either car docks or for truck docks . . . ready for instant use without installation expense. Sold nationwide by Material Handling Distributors.

One Man Operation
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Sturdy Construction
- ★ Made of heavy duty diamond safety plate
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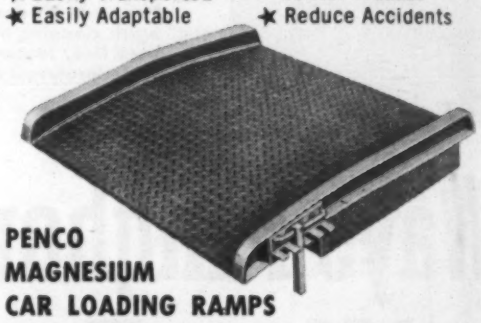
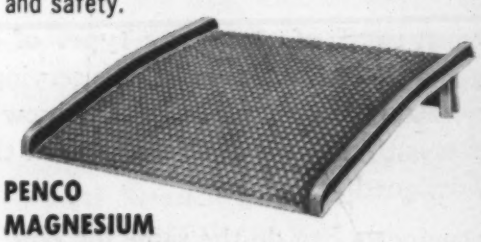


PENCO MAGNESIUM CAR LOADING RAMPS are made in both Flared and Rectangular (see photo) models in capacities from 3,000 to 10,000 pounds. Car Door Stops and full range positive Locking Device are Penco exclusive features that give wide adaptability and safety.



PENCO MAGNESIUM TRUCK LOADING RAMPS are made in both Single (see photo) and Two-Section types in capacities from 1,000 to 5,000 pounds...with exclusive Penco Ramp Stop . . . expedite operations using hand trucks, transporters or light fork trucks. The Penco Two-Section type is designed for use where materials handling equipment has a low under-clearance, and where loading docks are much lower than truck floors.

Send for descriptive literature—get all the facts on the many superior features available only in Penco Ramps. Penco also manufactures a wide range of steel models.

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BRONZE GEARS, BUSHINGS AND BEARINGS POSSESS LONGEVITY UNDER CONSTANT USAGE . . .

Heavy duty machinery, which requires rugged mechanical endurance necessitates the use of materials, which must perform for extended periods of time under severe strains.

The use of bronze under these conditions is a must. Only in bronze can be found the unusual combination of plasticity, durability, strength and wear resistance required.

FREE . . . Write for your copy of the 8 page Lavingot Technical Journal — Vol. 8, No. 4 containing an article discussing "Fume Control of the Brass Foundry."

Specify—LAVIN NONFERROUS INGOT—*Quality*

Brass · Aluminum · Bronze · Zinc Base Die Casting Alloys

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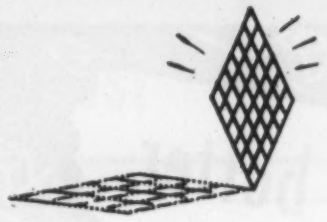
R. LAVIN & SONS, INC. 1900 53 Years 1953 SERVING THE FOUNDRY INDUSTRY

Cheapest "Diamonds" You Can Buy



METAL MARK Penmetal 1869 OF QUALITY

EXPANDED METAL

"Air Conditioning" FOR IRONING BOARDS

Experienced housewives prefer Ironing Boards with Penmetal Expanded Metal tops. They're stronger—lighter—non-warping for smoother ironing—"air-conditioned" to minimize pad scorching and accidental fire.

Dealers prefer them because they sell on sight—and for less.

Manufacturers prefer Penmetal Expanded Metal Mesh for countless applications. It's easily formed, shaped and welded . . . weighs less than solid sheets. Costs less, too.

Rid-Jid *Knee Room Adjustable All-Steel Ironing Table. Mfg. by: The J. R. Clark Co., Spring Park, Minn.*

EXPANDED METAL MESH

OPEN TO LIGHT, HEAT AND AIR. PENMETAL expanded metal is the material of economy—for protecting, for screening, for lightweight yet strong construction.

MAKES A LITTLE METAL GO A LONG WAY. PENMETAL expanded metal is sheet metal which has been slit, then stretched to as much as 10 times original area.

CORROSION-RESISTANT METALS AVAILABLE, as well as carbon steel. Large or small mesh, light or heavy gauge. Each sheet is a unit without rivets or welds.

UP TO 80% LIGHTER than solid sheet of same dimensions. Diamond truss pattern adds rigidity and strength.

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News Digest

Design Div., Marquette Coppersmithing Co., have been expanded recently to provide for a limited number of additional design projects.

A program to reduce the cost of finishing precision investment castings and supplying them complete to print has been announced by the *Hitchiner Products Corp.,* West Hartford, Conn. This company was activated primarily to finish the castings of the *Hitchiner Manufacturing Co., Inc.*, Milford, N. H.

Fibleco Illinois Corp. has moved into its new plant at 4628-46 N. Clifton Ave., Chicago.

Ford Motor Co. marks its 50th Anniversary this year. Highlight of a series of commemorative events planned for 1953 will be dedication of the company's $50,000,000 *Engineering and Research Center* in Dearborn, set for June 16, date of the company's incorporation in 1903.

The *Carl H. Biggs Co.* has moved to new and larger quarters at 2255 Barry Ave., Los Angeles.

Reed-Prentice Corp. has announced completion of a new factory building which provides 23,000 additional sq ft of space for the assembly of large vertical milling machines.

For clarity and simplicity, the corporate name of *Graham-Mintel Instrument Co.* has been changed to *Cleveland Instrument Co., Inc.*

Air Reduction Co., Inc., has announced expansion of its calcium carbide plant at Calvert City, Ky. The additional capacity is expected to be available early in 1954.

News of Societies

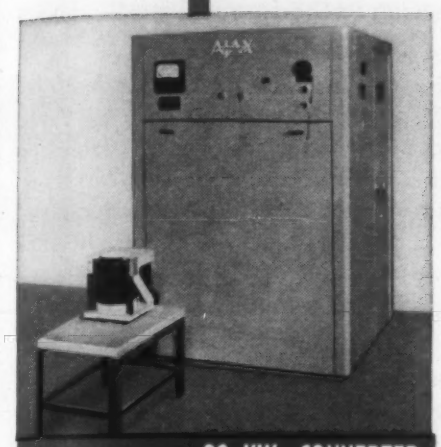
Frederick W. Fink, corrosion technologist at Battelle Memorial Institute, has been named chairman of the *Corrosion Div., Electrochemical Society.*

D. H. Cornell, manager of engineering services, B. F. Goodrich Co., has been given an appointment to serve on the *Professional Divs. Committee, American Society of Mechanical Engineers.*

Dr. J. D. Ryder, head of the Electrical Engineering Dept., University of Illinois, has been appointed president of the 1953 *National Electronics Conference, Inc.* Dr. C. E. Barthel, Jr., Illinois Institute of Technology, was named chairman of the board. The ninth annual conference will

Starting Point For Better Melting

AJAX-NORTHRUP CONVERTER-TYPE FURNACES



20 KW. CONVERTER

STEEL

BRASS

These compact, efficient furnaces are used in all leading metallurgical laboratories, and by the major producers of precision castings.

"Almost every new alloy since 1916 started in an Ajax-Northrup furnace."

The 20 Kw. converter will melt 17 pounds of steel in 40 minutes. Maximum capacity is 30 pounds of steel, or 60 pounds of bronze. The larger 40 Kw. unit melts faster, will handle up to 50 pounds of steel. The 6 Kw. unit melts a pound of steel in 8 minutes.

All units may be used for heat-treating, forging, sintering or other applications—no problem to change from one to the other.

Ajax-Northrup converters are completely self-contained. They can be placed anywhere in your plant where water and power are available, require no special foundation or wiring — and they're certified to meet F.C.C. regulations.

Many of today's "blue chip" industries started with a 20 Kw. Ajax-Northrup converter.

AJAX ELECTROTHERMIC CORPORATION
Ajax Park, Trenton 5, New Jersey

Associated Companies

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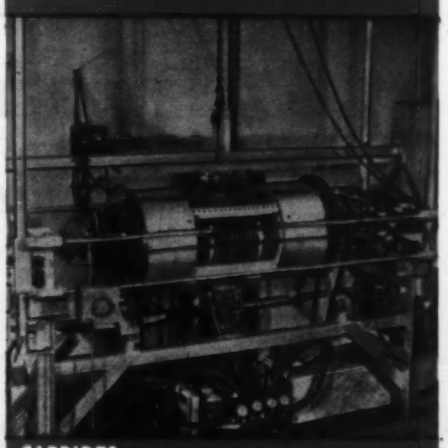
AJAX ELECTRIC FURNACE CORPORATION
AJAX ELECTRIC COMPANY, INC.
AJAX ENGINEERING CORPORATION

RESEARCH



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INDUCTION HEATING AND MELTING

Since 1916

151

J-M BLAZECRETE speeds refractory repairs...

That's why it pays you to use this hydraulic setting refractory for temperatures to 3000F

REPAIR old refractory linings—or build new ones—quickly and economically with Blazecrete*. For troweling, just mix Blazecrete with water as you'd mix ordinary concrete . . . then slap-trowel it in place.

When gunned, it adheres readily with a minimum of rebound loss. Either way, Blazecrete goes on fast . . . without laborious ramming or tamping. *And Blazecrete linings last.*

Three types of hydraulic-setting Blazecrete are available. All harden on air curing, do not require prefiring. They are furnished as a dry mix . . . can be stored safely for use as needed.

3X BLAZECRETE—For temperatures through 3000F. Unusually effective for heavy patching, especially where brickwork is spalled or deeply eroded. Excellent for forge furnace linings, lime kilns, burner blocks, soaking pits, and industrial boilers.

STANDARD BLAZECRETE—For temperatures through 2400F. Makes repair work easier and less costly. Can be used by boiler manufacturers to replace fire clay tile in wall construction. Suitable for use in combination with 3X Blazecrete and L. W. Blazecrete.

L. W. BLAZECRETE—For temperatures through 2000F. An insulating refractory . . . light in weight, low in thermal conductivity. Adaptable and economical for many other applications.

Send for Brochure RC-28A on Blazecrete and its companion material, Firecrete*. . . the hydraulic setting castable refractory for making special shapes and linings. Write Johns-Manville, Box 60, New York 16, N. Y. In Canada, 199 Bay St., Toronto 1, Ontario.

*Reg. U.S. Pat. Off.

Whether you gun it... *or slap-trowel it...*

Johns-Manville **BLAZECRETE**

BUILDS BETTER REFRACTORY LININGS

News Digest

be held Sept. 28, 29 and 30, 1953 at the Hotel Sherman in Chicago.

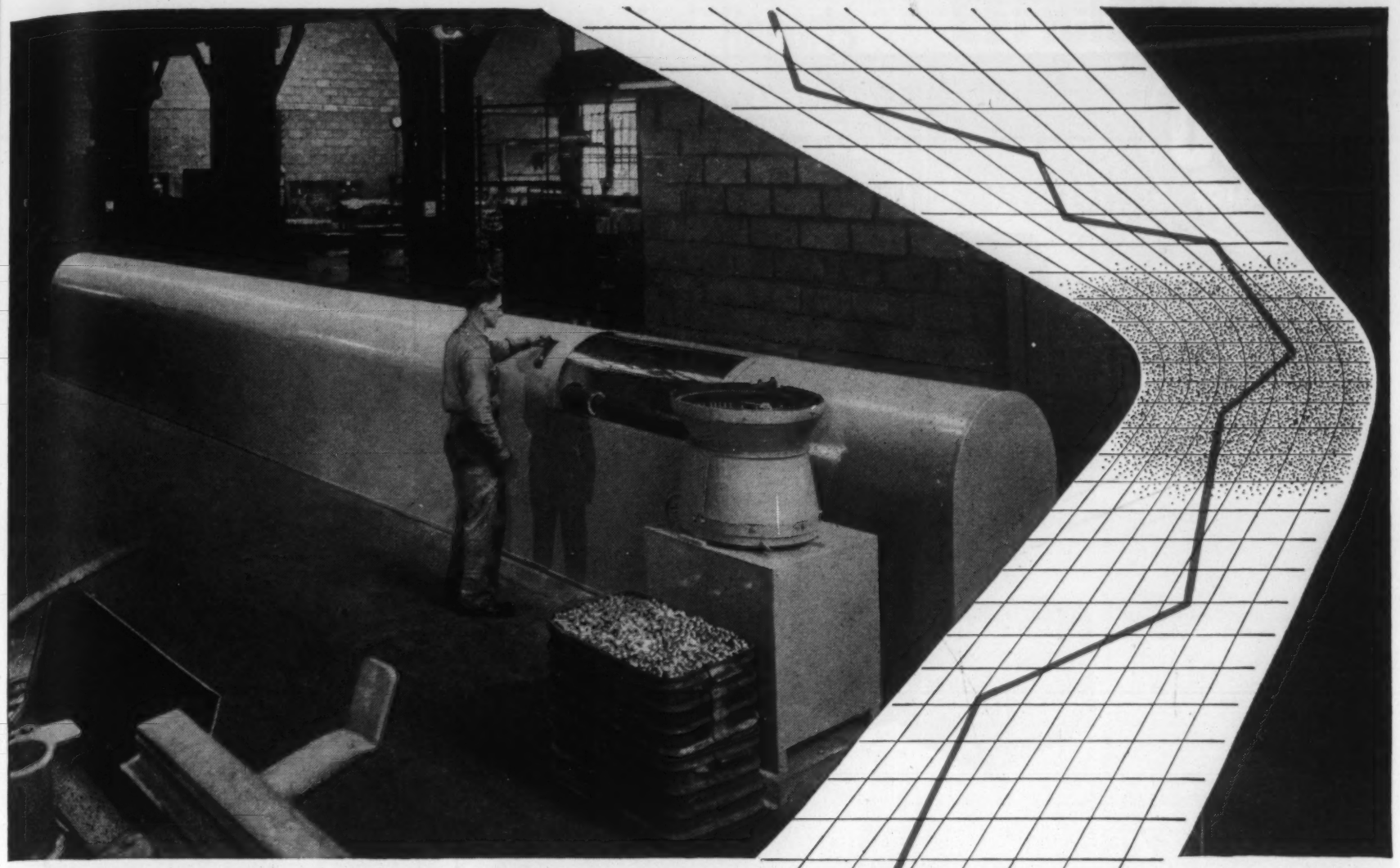
As part of its expanding research and educational program, the *Association of Iron and Steel Engineering* is establishing a Fellowship for graduate study and research at the *Carnegie Institute of Technology*. The purpose of the fellowship is to select and train outstanding men for engineering in the iron and steel industry.

Fifteen fellowships are being offered in 1953 by the *Institute of Gas Technology*, an affiliate of *Illinois Institute of Technology*. Two programs are available for graduate students preparing for careers in the gas company. One offers a master of science degree in mechanical or chemical engineering in 15 months; the other a master of gas technology degree in two years.

A new professorship in mechanical engineering has been established at *Carnegie Institute of Technology* through a grant from Aluminum Co. of America. The new chair will be held by Dr. Dennistoun Wood VerPlanck, professor and head of Carnegie's Mechanical Engineering Dept. Part of the grant of $15,000 a year will be used for research and equipment.

Election of Robert Cass, assistant to the president, White Motor Co., as 1953 president of the *Society of Automotive Engineers*, has been announced. Mr. Cass succeeds Dr. D. P. Barnard, of Standard Oil Co., who served as the SAE 1952 president. SAE has also announced that L. F. Dumont, research engineer in the petroleum laboratory of E. I. du Pont, received the Horning Memorial Award at the 1953 annual meeting in Detroit.

Everett N. McDonnell, president, McDonnell & Miller, Inc., has been selected to receive the 1952 F. Paul Anderson Medal of the *American Society of Heating and Ventilating Engineers*, according to a recent announcement from the Society.



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KEEP COSTS DOWN . . . *through automatic production that gives quality control*

Alnico magnets have been getting smaller and lighter, thanks to production techniques in use at Crucible. Automatic machinery cuts the possibility of human error to a minimum, so rejections are low. This helps to maintain stable price levels in the face of rising material and labor costs. At the same time, Crucible's rigid inspection standards and attention to quality have developed a magnet with the *highest gap flux per unit weight of any on the market.*

Today, Crucible can offer lighter, magnetically stronger Alnico magnets because of these automatic production techniques developed over the sixteen years that we have been producing the Alnico alloys. And behind our familiarity with permanent magnets lies more than 52 years' experience with specialty steelmaking. Let us advise you on your magnet problem.

Visit our booth No. 4-203 at the I.R.E. show in New York City, March 23-26

CRUCIBLE first name in special purpose steels

53 *years of Fine steelmaking*

PERMANENT ALNICO MAGNETS

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• Always the leader . . . recognized and respected. Its quality has been imitated, but never attained. The WILSON "ROCKWELL" sets itself apart—stands alone—as the jewel of Hardness Testers. WILSON accepts the responsibility of leadership.

The many models of WILSON "ROCKWELL" for normal and superficial hardness testing offer the utmost in production as well as laboratory work. The various models of WILSON TUKON micro and macro hardness testers cover the entire range of scientific uses. Standards set by WILSON "ROCKWELL" and TUKON testers are accepted everywhere.

Be sure. Look to WILSON for the hardness testers you need. Don't be satisfied with anything less than a genuine "ROCKWELL." It may cost less than you think.

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WILSON "ROCKWELL" and TUKON Hardness Testers

Meetings and Expositions

AMERICAN SOCIETY FOR METALS, Western metal congress and exposition. Los Angeles. Mar. 23-27, 1953.

PRESSED METAL INSTITUTE, spring technical meeting. Cleveland. Mar. 25-27, 1953.

SOCIETY OF AUTOMOTIVE ENGINEERS, production meeting. Cleveland. Mar. 25-27, 1953.

MAGNESIUM ASSOCIATION, international magnesium exposition. Washington, D. C. Mar. 31-Apr. 2, 1953.

MALLEABLE FOUNDERS' SOCIETY, market development conference. Ithaca, N. Y. Apr. 9-10, 1953.

ELECTROCHEMICAL SOCIETY, spring meeting. New York. Apr. 12-16, 1953.

INTERNATIONAL ACETYLENE ASSOCIATION, annual meeting. Atlanta. Apr. 13-15, 1953.

METAL POWDER ASSOCIATION, annual meeting. Cleveland. Apr. 20-22, 1953.

SOCIETY OF AUTOMOTIVE ENGINEERS, spring aeronautical meeting. New York. Apr. 20-23, 1953.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, spring meeting. Columbus. Apr. 28-30, 1953.

OAK RIDGE INSTITUTE OF NUCLEAR STUDIES, symposium. Oak Ridge, Tenn. Apr. 30-May 1, 1953.

AMERICAN FOUNDRYMEN'S SOCIETY, annual convention. Chicago. May 4-8, 1953.

SOCIETY OF THE PLASTICS INDUSTRY, annual meeting. On board the Queen of Bermuda—New York to Burmuda and back. May 9-15, 1953.

AMERICAN INSTITUTE OF MINING & METALLURGICAL ENGINEERS, Pacific Northwest metals and mineral conference, joint meeting, Metals Branch and Industrial Minerals Div. Seattle. May 14-16, 1953.

SOCIETY OF AUTOMOTIVE ENGINEERS, summer meeting. Atlantic City. June 7-12, 1953.

MALLEABLE FOUNDERS' SOCIETY, annual meeting. Hot Springs, Va. June 8-10, 1953.

AMERICAN ELECTROPLATERS' SOCIETY, annual meeting. Philadelphia. June 15-18, 1953.

FIRST EXPOSITION OF BASIC MATERIALS FOR INDUSTRY, New York. June 15-19, 1953.

AMERICAN WELDING SOCIETY, national spring technical meeting. Houston. June 16-19, 1953.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, semi-annual meeting. Los Angeles. June 28-July 2, 1953.

AMERICAN SOCIETY FOR TESTING MATERIALS, annual meeting. Atlantic City, N. J. June 29- July 3, 1953.

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SAVINGS
to VOLUME users
of small parts

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Technical Reports on Materials

Ferrous

INFLUENCE OF CHEMICAL COMPOSITION ON RUPTURE PROPERTIES AT 1200 F OF FORGED CHROMIUM-COBALT-NICKEL-IRON BASE ALLOYS IN SOLUTION-TREATED AND AGED CONDITION. *Reynolds, Freeman and White, University of Michigan (1951). NACA Report 1058 (formerly TN 2449), 60 pp. Available from National Advisory Committee for Aeronautics, 1724 F St., Washington 25, D. C.*

INFLUENCE OF NONMARTENSITIC TRANSFORMATION PRODUCTS ON MECHANICAL PROPERTIES OF TEMPERED MARTENSITE. *Hodge and Lankford, U. S. Steel Corp. (1952). NACA TN 2862, 12 pp. Available from National Advisory Committee for Aeronautics, 1724 F St., Washington 25, D. C.* Effects of upper bainite in amounts of 1, 5, 10 and 50%, of 5% ferrite and 5% pearlite on tensile, impact and fatigue properties of SAE 4340 steel.

EFFECT OF DECARBURIZATION AND OTHER FACTORS ON THE FATIGUE STRENGTH OF ROLL-THREADED AIRCRAFT BOLTS. *Svenska Aeroplan Aktiebolaget. Linkoping, Sweden (1952). Report PB 107754, 19 pp. Available from Library of Congress, Publication Board Project, Washington 25, D. C. Microfilm $1.75, photostat $2.50.* Fatigue strength of such bolts seriously affected by certain types of laps but only slightly by decarburization. Threading after heat treating increased fatigue strength considerably.

Nonferrous

GRAIN REFINEMENT IN ALUMINUM-SILICON (5% SI) AND ALUMINUM-SILICON-MAGNESIUM (7% SI, 0.3% MG) CASTING ALLOYS. *U. S. Naval Gun Factory. Report PB 107603, 17 pp. Available from Library of Congress, Photoduplication Section, Washington 25, D. C. Microfilm $1.75, photostat $2.50.* Boron, Cb, Ti, Zr, Ta, Mo, W, Cr and Be, in that order of effectiveness, were found to refine the grain size of the two casting alloys. The grain refiners altered the shape and distribution of the Si constituent in the microstructure.

TITANIUM AND TITANIUM-BASE ALLOYS. *Battelle Memorial Institute. Report PB 107399, 168 pp. Available from Library of Congress, Photoduplication Section, Washington 25, D.C. Microfilm $6.25, photostat $2.25.* Details of reduction processes investigated at Battelle; properties of metal processed by U. S. Bureau of Mines and P. R. Mallory & Co.; arc melting of titanium and its alloys at Battelle; effect of oxygen, nitrogen and hydrogen on iodide titanium; alloys prepared by powder metallurgy methods; room temperature properties of arc-melted titanium and its alloys; comparisons of the properties of titanium and its alloys with those of other materials; fabricating characteristics; chemical analysis.

TITANIUM - ALUMINUM - CHROMIUM ALLOYS. FINAL REPORT. *New York University (1952). Report PB 107716, 41 pp. Available from Library of Congress, Publication Board Project, Washington 25, D. C. Microfilm $2.50, photostat $6.25.* Phase relationships for four isothermal sections in the temperature region 1200 to 1920 F and in the composition range up to 60% chromium and 45% aluminum.

SUBGRAIN STRUCTURE IN LEAD AND LEAD-ANTIMONY ALLOYS. *Report PB 106611. Available from Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D. C. Mimeo $.75.*

THE RELATIONSHIP BETWEEN THE CREEP AND TENSILE PROPERTIES AT ELEVATED TEMPERATURE OF NIMONIC 80. *Graham and Walles, National Gas Turbine Establishment, Great*

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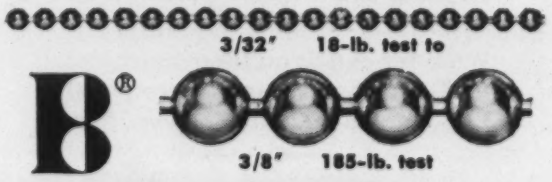

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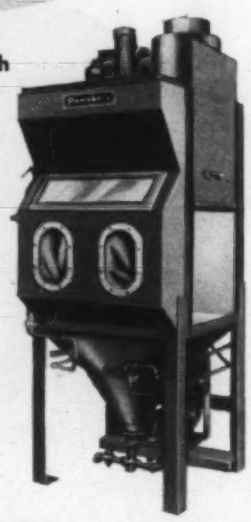

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continued from page 213

Britain (1952). Report N-20200, 45 pp. Available on loan from NACA, 1724 F St., Washington 25, D. C.

Plastics

ULTRA-HIGH FREQUENCY HIGH TEMPERATURE DIELECTRIC MATERIALS. *Polaroid Corp. (1950). Report PB 107574, 31 pp. Available from Library of Congress, Publication Board Project, Washington 25, D. C. Microfilm $2.25, photostat $5.00.*

DEVELOPMENT OF SIZINGS FOR GLASS FABRIC IN POLYESTER-RESIN LAMINATES. *Bjorksten Research Laboratories, Inc. (1951). Report PB 107770, 115 pp. Available from Library of Congress, Publication Board Project, Washington 25, D. C. Microfilm $4.75, photostat $15.00.* Sizings of vinyl dichloro silane, in conjunction with beta chloro allyl alcohol, applied to heat-cleaned glass fabric improve wet-strength properties of low-pressure laminates.

THE ELECTRICAL PROPERTIES OF PENTACHLORDIPHENYL-IMPREGNATED GLASS FIBER PAPER. *Naval Research Laboratory. Report PB 111030. Available from Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D. C. Mimeo $.50.*

Parts & Forms

INVESTIGATION OF A METHOD OF CASTING CERMETS DISPERSED BY MECHANICAL MEANS. *New York State College of Ceramics (1951). Report PB 107676, 21 pp. Available from Library of Congress, Publication Board Project, Washington 25, D. C. Microfilm $2.00, photostat $3.75.*

USE AND INTERPRETATION OF THE NRL EXPLOSION BULGE TEST. *U. S. Naval Research Laboratory (1952). Report PB 111060, 40 pp. Available from Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D. C. Mimeo $.75.* Use and significance of method for investigating performance of weldments on model scale.

APPLICATIONS OF SHELL MOLDING TO THE PRODUCTION OF MAGNESIUM CASTINGS. FINAL REPORT. *Dow Chemical Co. (1952). Report PB 111049, 29 pp. Available from Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D. C. Mimeo $.75.* Principles developed in the investigation were applied to a production casting. Tensile properties of shell mold casting were equivalent to those of same part cast in green sand and permanent molds.

REPORT OF INVESTIGATION OF THE SHELL MOLDING PROCESS. *O. T. S. Report PB 111004. Available from Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D. C. Mimeo $1.50.* Technical advances which will make possible wider application of the new casting process. Recommendations by Navy metallurgists.

LIGHTWEIGHT WAVEGUIDES. FINAL REPORT. *Armour Research Foundation. Report PB 107412, 41 pp. Available from Library of Congress, Photoduplication Section, Washington 25, D. C.*

Joining

BONDING MATERIALS, METALLIC MATING SURFACES: LOW RF IMPEDANCE. SUMMARY REPORT. *Armour Research Foundation. Report PB 107359, 28 pp. Available from Library of Congress, Photoduplication Section, Washington 25, D. C. Microfilm $2.00, photostat $3.75.* Fabrication and testing of low-radio-frequency-impedance bonding materials to be used between mating surfaces of shielding cans that enclose airborne electrical and electronic equipment and aircraft ignition systems.

WELDING, MOTION PICTURES, TECHNIQUES AND APPLICATIONS. *O. T. S. Report PB*

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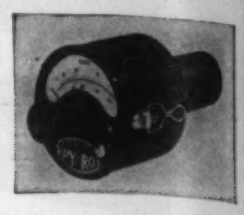

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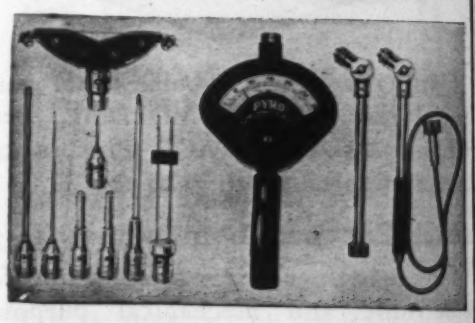

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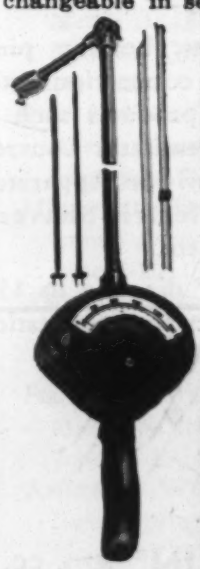

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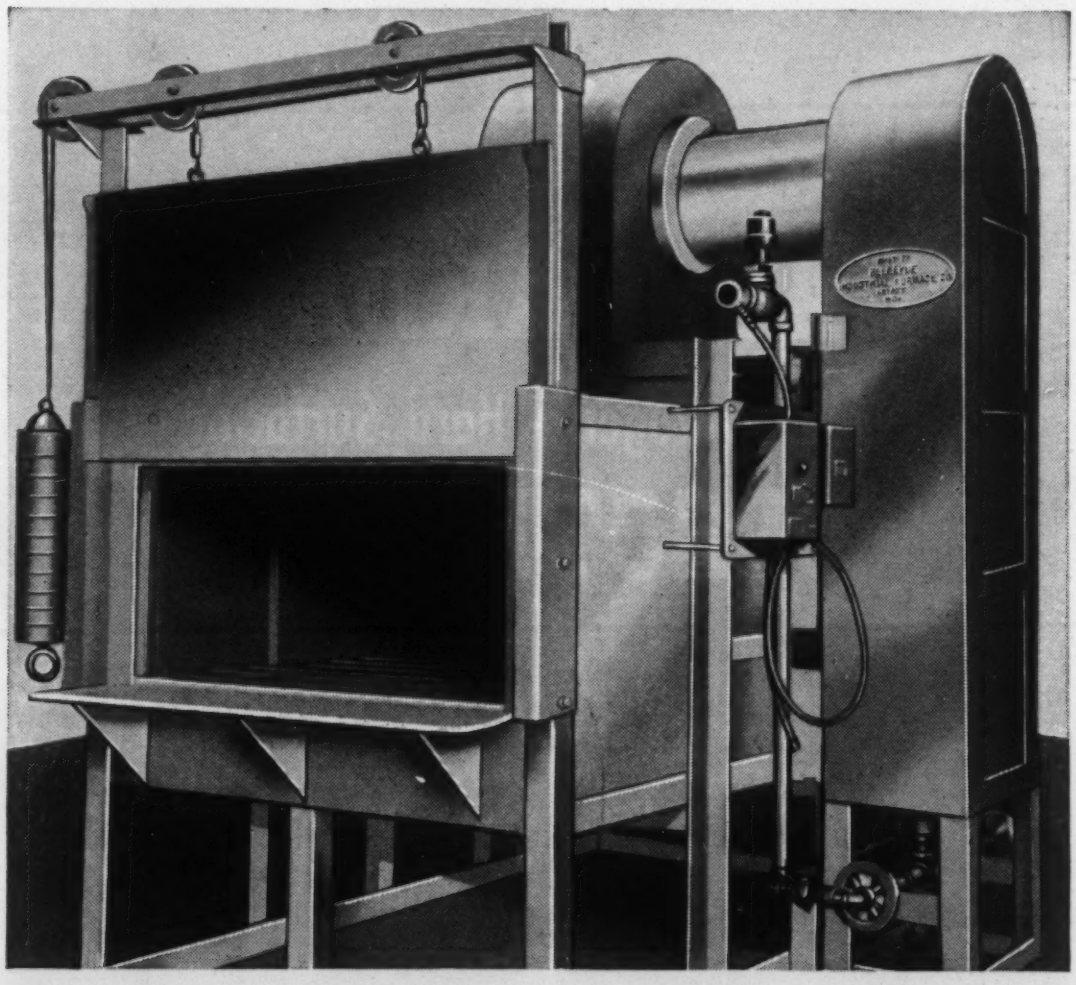

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Technical Reports . . . .

continued from page 214

111037. Available from Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D. C. Mimeo $.75. Bibliography of 87 films on welding techniques and applications available on free-loan basis.

THE COMPARATIVE DURABILITY OF PLYWOOD GLUES IN ENGLAND AND IN NIGERIA (SERIES IV). SECOND YEAR'S ANALYSIS. (INVESTIGATIONS INTO GLUES AND GLUING PROGRESS REPORT 69, 1952). *Carruthers, Burgess and Thomas, Forest Products Research Laboratory, Great Britain. Report N-20231, 11 pp. Available on loan from National Advisory Committee for Aeronautics, 1724 F St., Washington 25, D. C.*

THE DURABILITY OF ASSEMBLY GLUES—SERIES A. FIFTH YEAR REPORT ON THE PLYCLAD FRAME TESTS. (INVESTIGATIONS INTO GLUES AND GLUING PROGRESS REPORT 64, 1952). *Knight, Doman and Soane, Forest Products Research Laboratory, Great Britain. Report N-20232, 14 pp. Available on loan from National Advisory Committee for Aeronautics, 1724 F St., Washington 25, D. C.*

DURABILITY OF ASSEMBLY GLUES—SERIES B. FIFTH YEAR REPORT ON LAMINATED BEAMS. (INVESTIGATIONS INTO GLUES AND GLUING PROGRESS REPORT 68, 1952). *Newall and Grosert, Forest Products Research Laboratory, Great Britain. Available on loan from National Advisory Committee for Aeronautics, 1724 F St., Washington 25, D. C.*

General

SURFACE AREAS OF METALS AND METAL COMPOUNDS. A RAPID METHOD OF DETERMINATION. *Report PB 107448, 6 pp. Available from Georgia Institute of Technology, State Engineering Experiment Station, Atlanta, Ga.* Determination of absorptive properties of metal surfaces, corrosion prevention and surface testing.

EFFECTS OF SOLVENTS IN IMPROVING BOUNDARY LUBRICATION OF STEEL BY SILICONES. *NACA. Report PB 107561, 23 pp. Available from National Advisory Committee for Aeronautics, 1724 F St., Washington 25, D. C.*

A SPECIAL INVESTIGATION TO DEVELOP A GENERAL METHOD FOR THREE-DIMENSIONAL PHOTOELASTIC STRESS ANALYSIS. *Frocht and Guernsey, Illinois Institute of Technology (1952). NACA TN 2822, 59 pp. Available from National Advisory Committee for Aeronautics, 1724 F St., Washington 25, D. C.* New method shows possibilities of high accuracy in stress analysis.

PAST WORK ON FATIGUE OF METALS IN THE HIGH TEMPERATURE FIELD, *Illinois University (1950). Report PB 107702, 49 pp. Available from Library of Congress, Publication Board Project, Washington 25, D. C. Microfilm $2.50, photostat $6.25.* Review and evaluation. Conclusion: fundamental information is needed on the nature of the phenomena limiting the life of a metal in high temperature fatigue before accurate methods can be evolved for prediction of useful service life of specific components.

A DIRECT, EASILY COMPUTABLE METHOD FOR THE EVALUATION OF CENTRIFUGAL AND THERMAL STRESSES IN DISKS, AND STRESS CHANGES DUE TO PLASTIC FLOW AND CREEP. *Brooking, Brown and Atkins, National Gas Turbine Establishment, Great Britain (1952). Report N-17876, 68 pp. Available on loan from National Advisory Committee for Aeronautics, 1724 F St., Washington 25, D. C.*

ON THE DEVELOPMENT OF RECENT GRINDING, LAPPING AND POLISHING MATERIALS. *Report PB 107452, 16 pp. Available from Library of Congress, Photoduplication Section, Washington 25, D. C. Microfilm $1.75, photostat $2.50.* Abrasives, diamond tools, grinding wheels, boron carbide uses and polishing materials in Germany.

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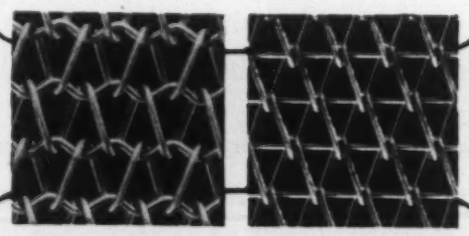

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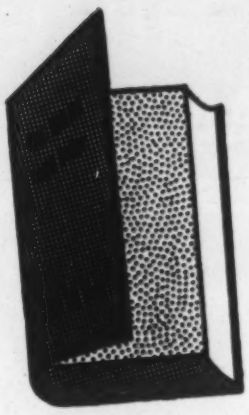

BOOK REVIEWS

SURFACE PREPARATION SPECIFICATIONS. *Published by Steel Structures Painting Council, Pittsburgh 13, Pa., 1952. Paper, 8½ by 11 in. Price, $1.00 for Series of 9 Specifications.* Offered here is a series of nine Surface Preparation Specifications which includes the following: (1) Solvent Cleaning; (2) Hand Cleaning; (3) Power Tool Cleaning; (4) Flame Cleaning of New Steel; (5) Blast Cleaning to "White" Metal; (6) Commercial Blast Cleaning; (7) Brush-Off Blast Cleaning; (8) Pickling; and (9) Weathering and Cleaning.

WELDING PROCESSES AND PROCEDURES EMPLOYED IN JOINING STAINLESS STEELS. *By Helmut Thielsch. Published by Welding Research Council, Bulletin 14, New York 18, N. Y., 1952. Paper, 8 by 11 in., 48 pp. Price $2.00.* Here is a detailed handbook-type review of published and the latest unpublished information on metal-arc welding, carbon-arc welding, gas welding, resistance welding, and flame cutting of stainless steels —including the recent developments and modifications of these processes. Welding characteristics, advantages and limitations of the various processes, as well as the recommended procedures are discussed in detail. Detailed tables are also included giving welding recommendations for electrode or filler-metal wire sizes, current and voltage settings, welding speeds, joint designs, etc., for different sizes of stainless steel base metal to be welded or cut.

METAL FINISHING 1953 GUIDEBOOK DIRECTORY. *Edited by Nathaniel Hall. Published by Finishing Publications, Inc., Westwood, N. J., 1952. Paper, 5½ by 8 in., 556 pp. Price, $3.00.* This 556-page comprehensive handbook covers all operations of metal finishing compiled by well-known authorities. Contents include: Plant Engineering; Mechanical Surface Preparation; Plating Solutions and Operating Data; Special Plating Procedures; Control—Analysis—Testing; Tables and Data Sheets; Directory of Suppliers; Manufacturers, Products and Trade Names; Metal Finishing Consultants; Schools Teaching Electroplating; Engineering Societies in the Engineering Field; Selected List of Reference Books.

TEXTBOOK OF ENGINEERING MATERIALS. *By Melvin Nord. Published by John Wiley & Sons, Inc., New York, N. Y., 1952. Cloth, 6 by 9 in., 518 pp. Price $6.50.* This text is primarily written as a one-semester course for all engineering students at the lower sophomore or upper freshman level. The first half of the work is a general treatment of the subject. Beginning at an elementary level, it introduces fundamental concepts in physics, chemistry and other basic subjects. In the second half of the book, the specific materials of engineering are treated in the light of the generalizations made.

STANDARD METAL DIRECTORY. *Published by Atlas Publishing Co., Inc., New York, N. Y., 1952. Cloth, 6 by 9 in., 927 pp. Price $15.00.*

(Continued on Page 220)

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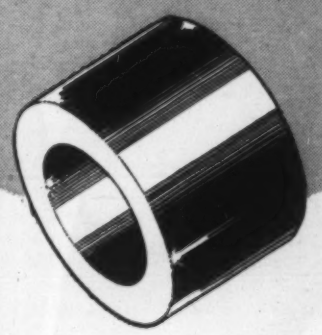

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Book Reviews

(continued)

This 13th edition of the Directory provides a valuable reference for those who are in any branch of the steel and metal industries. It is of special value to purchasing agents and manufacturers. The Directory is divided into four sections: iron and steel plants; ferrous and nonferrous metal foundries; metal rolling mills; and smelters of nonferrous metals. More than 10,000 detailed reports on plants located in the United States and Canada are given. Information presented includes company name, capitalization, plant equipment, products manufactured, primary and secondary raw materials consumed, company officials, purchasing agent and sales manager.

ADVANCED MECHANICS OF MATERIALS. *By Fred B. Seely and James O. Smith. Published by John Wiley & Sons, Inc., New York 16, N. Y., 1952. Cloth, 6 by 9 in., 680 pp. Price $8.50.* Treatment in this second edition has been made more penetrating and comprehensive, and much new material has been added. Although methods of analysis are given careful attention throughout the book, equal emphasis is given to engineering evaluation and interpretation of the analyses as influenced by the assumptions made and principles used. The book consists of six parts, two new parts having been added: The Influence of Small Inelastic Strains on the Load-Carrying Capacity of Members; and Introduction to Instability—Buckling Loads.

AUTOMATION. *By John Diebold. Published by D. Van Nostrand and Co., Inc., New York 3, N. Y., 1952. Cloth, 6 by 9 in., 181 pp. Price, $3.00.* In this first popular book of its kind, the author gives a provocative account of the possibilities, limitations and social and economic consequences of the revolutionary new machines of the electronic age that correct their own errors and carry on complex and repetitive functions with skill and precision. Presented here is a thoughtful and imaginative picture of a new technological era with its necessitated problems of readjustment and rethinking including many actual case histories of office and factory, in education, management and engineering.

SOLUBLE SILICATES, VOLUME 2, AMERICAN CHEMICAL SOCIETY MONOGRAPH #116. *By James G. Vail. Published by Reinhold Publishing Corp., New York 36, N. Y., 1952. Cloth, 6 by 9 in., 669 pp. Price $15.00.* Here is the second of a comprehensive 2-volume monograph written to replace the out-of-print *Soluble Silicates in Industry* (ACS Monograph #46). These two volumes comprise the only treatise to offer complete review of the known properties and industrial applications of soluble silicates. Volume 2 deals with the more practical considerations involving the applications of soluble silicates to industry. Here are described the film-forming properties of silicates and their uses in all manner of industrial materials and techniques, including adhesives, laminates, sizing, fire protection, cements and plastics.

HOW TO CONTROL PRODUCTION COSTS. *By Phil Carroll. McGraw-Hill Book Co., New York 36, N. Y., 1953. Cloth, 6 by 9 in., 272 pp. Price $5.00.* Designed for men in the management group as well as for accountants, this book shows the reader how to get more accurate costs and how to control them. A helpful new approach is taken in applying overhead expense (1) in terms of conversion time, and (2) in accordance with rates caused by the different products in multiproduct industry.

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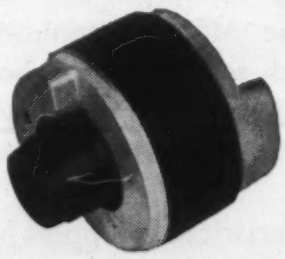

Close-up of aluminum die cast rotor, which is pressed onto the compressor shaft extension used in refrigeration units.

Our electrical industry produces fractional horse power motors at the rate of 20 to 25 millions per year. After World War II the leading manufacturers changed from fabricated copper rotors to cast aluminum rotors. In this operation, aluminum of high purity under closely controlled temperature is required. In many cases the machines had to be placed right on the assembly line, with severe space restrictions and, of course, rigid requirements for reliability. AJAX induction furnaces and AJAX automatic pouring units were selected for this job in almost all the plants which switched from copper to aluminum rotors.

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